Issued April 8, 1911.

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF SOILS—MILTON WHITNEY, Chief.

IN COOPERATION WITH THE PENNSYLVANIA STATE COLLEGE
AGRICULTURAL EXPERIMENT STATION,
THOMAS F. HUNT, DIRECTOR.

A RECONNOISSANCE SOIL SURVEY OF SOUTH-WESTERN PENNSYLVANIA.

BY

HENRY J. WILDER, OF THE U. S. DEPARTMENT OF AGRICULTURE,
AND CHARLES F. SHAW, OF THE PENNSYLVANIA
AGRICULTURAL EXPERIMENT STATION.

[Advance Sheets—Field Operations of the Bureau of Soils, 1909.]

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1911.

[PUBLIC RESOLUTION—No. 9.]

JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided,* That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the Congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils.]

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., June 16, 1910.

SIR: The accompanying manuscript report and map cover the extension of the reconnoissance soil survey of the Appalachian region during the field season of 1909. Work was completed in 11 counties in southwest Pennsylvania, the area adjoining on the south the area covered by the reconnoissance work of the preceding year. The territory has an extent of 7,911 square miles and the map is constructed on a scale of 4 miles to the inch.

I recommend that the report be published as advance sheets of the Report of Field Operations of the Bureau of Soils for 1909, as authorized by law.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

CONTENTS.

	Page.
A Reconnoissance Soil Survey of Southwestern Pennsylvania. By Henry J. Wilder, of the U. S. Department of Agriculture, and Charles F. Shaw, of the Pennsylvania Agricultural Experiment Station	5
Introduction	5
Soils	6
Upland soils	12
Dekalb soils	12
Fayette and Westmoreland counties	15
Indiana County	16
Armstrong County	18
Butler County	20
Clarion County	21
Jefferson County	23
Westmoreland soils	25
Fayette County	27
Westmoreland County	29
Indiana and Armstrong counties	29
Washington and Greene counties	29
Allegheny County	30
Butler County	33
Beaver County	35
Brooke soils	39
Volusia soils	42
Colluvial soils	44
Jefferson soils	44
Terrace and bottom-land soils	46
Genesee soils	46
Huntington soils	47
Wheeling soils	47
Kittanning soils	48
Climate	49
Review of the development of agriculture in the area	50
Present agricultural practices	53
Suggestions for soil improvement	57
Orcharding	67
Summary	68

ILLUSTRATIONS.

FIGURES.

		Page.
FIG. 1.	Sketch map showing reconnoissance survey of southwestern Pennsylvania	5
2.	Sketch map showing the principal divisions of the Allegheny Plateau and the Appalachian Mountains and Valleys section and the areas in the former occupied by the different geological formations	7
3.	Map showing the area of the Pittsburg coal in Pennsylvania	11
4.	Map showing the extent of the northern part of the Appalachian coal field	12

MAP.

Soil map, reconnoissance survey, southwestern Pennsylvania sheet.

A RECONNOISSANCE SOIL SURVEY OF SOUTHWESTERN PENNSYLVANIA.

By HENRY J. WILDER, of the United States Department of Agriculture, and CHARLES F. SHAW, of the Pennsylvania Agricultural Experiment Station.

INTRODUCTION.

During the second year of the reconnoissance soil survey of the Appalachian Mountain and Plateau Region of the United States, 11 counties in southwest Pennsylvania were completed, comprising an area of 7,911 square miles. The counties surveyed were Beaver, Butler, Clarion, Jefferson, Washington, Allegheny, Armstrong, Indiana, Westmoreland, Fayette, and Greene. This group of counties

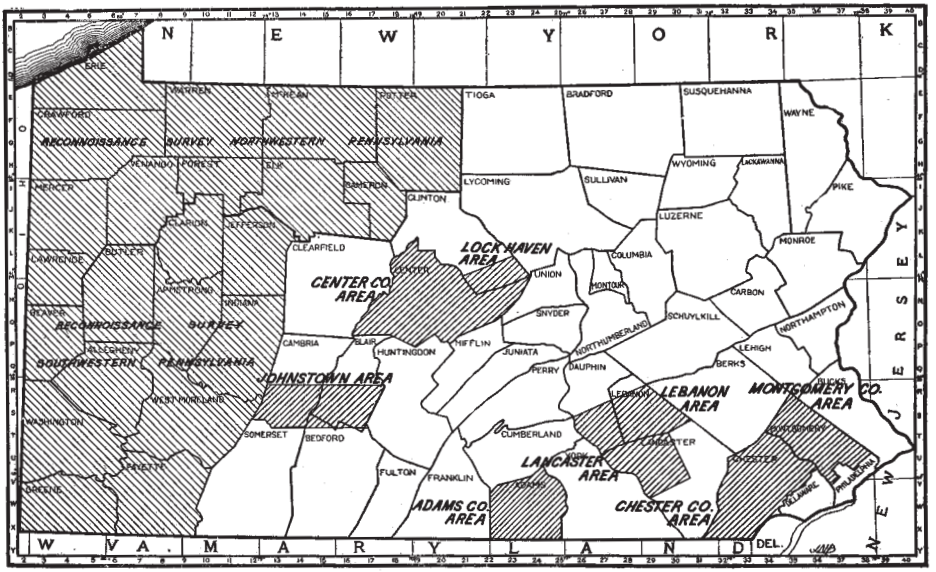

FIG. 1.—Sketch map showing reconnoissance survey of southwestern Pennsylvania.

adjoins the area covered in the reconnoissance survey of the northwestern part of the State in 1908, and extends thence southward to Maryland and West Virginia and westward to Ohio and the northern pan-handle of West Virginia. Of this entire district Pittsburg is the commercial center from which nearly all lines of activity radiate; hence this survey and report concern the agricultural soils

and their possibilities in a region of intense industrial development. The peculiar combination of conditions and circumstances existing makes this region unique among eastern centers of population, including their surrounding and contributory suburbs.

SOILS.

In southwestern Pennsylvania the soils have been classified into four upland series, one colluvial series, and four terrace series. Meadow, consisting of poorly drained areas along streams, and small swampy areas sometimes occur, but not of sufficient extent to be shown on the scale used in the eastern reconnoissance work, viz, 1 inch=4 miles, and so have been included in the first terrace soils.

The occurrence of the soils and their grouping may be most easily understood perhaps by a brief description of the general topographic division and features of the region.

The area mapped lies entirely within the Allegheny Plateau province. In figure 2 is shown the location of this plateau in southwest Pennsylvania, its three general divisions, and an outline of the district mapped as related to them.

The elevation of the Allegheny Front at the Maryland-Pennsylvania line is about 2,800 feet above tide. From that point north the elevation decreases 400 to 500 feet toward the center of the State, and finally the Front appears to merge into the general plateau level, though it can be traced far beyond the limits of the area to the northeast part of the State by remnants of its ancient form. The crest of the Allegheny Front marks the division between the soil province known as the Appalachian mountains and valleys on the east and that of the Allegheny plateaus on the west. To the east of this break, as the name implies, the surface configuration is severe as the result of crumplings and upheavals incident to an ancient mountain system. On the west side of the crest the broad basal lines of a plateau stretch afar, broken only by two minor mountain ranges, Laurel Hill and the Laurel-Chestnut Ridge, both of which run parallel to the Allegheny Front from Fayette to Lycoming County, a distance of 150 miles, and divide the plateau and likewise the area surveyed into three parts. Of these topographic divisions the eastern and middle appear as synclinal troughs, or local upland valleys bounded on each side by well-defined ridges. The southeast part of the area mapped extends across Laurel Ridge in Fayette County and thus includes a small area within the eastern trough. West of Laurel-Chestnut Ridge there is a gradual slope to the Ohio line.

In both of these divisions the surface is deeply dissected. In fact, local topography is often so broken and irregular that it obscures the relation of some particular section to the plateau surface as a whole.

At any point below the level of the highest hills within each topographic division the region seems to consist of an endless succession

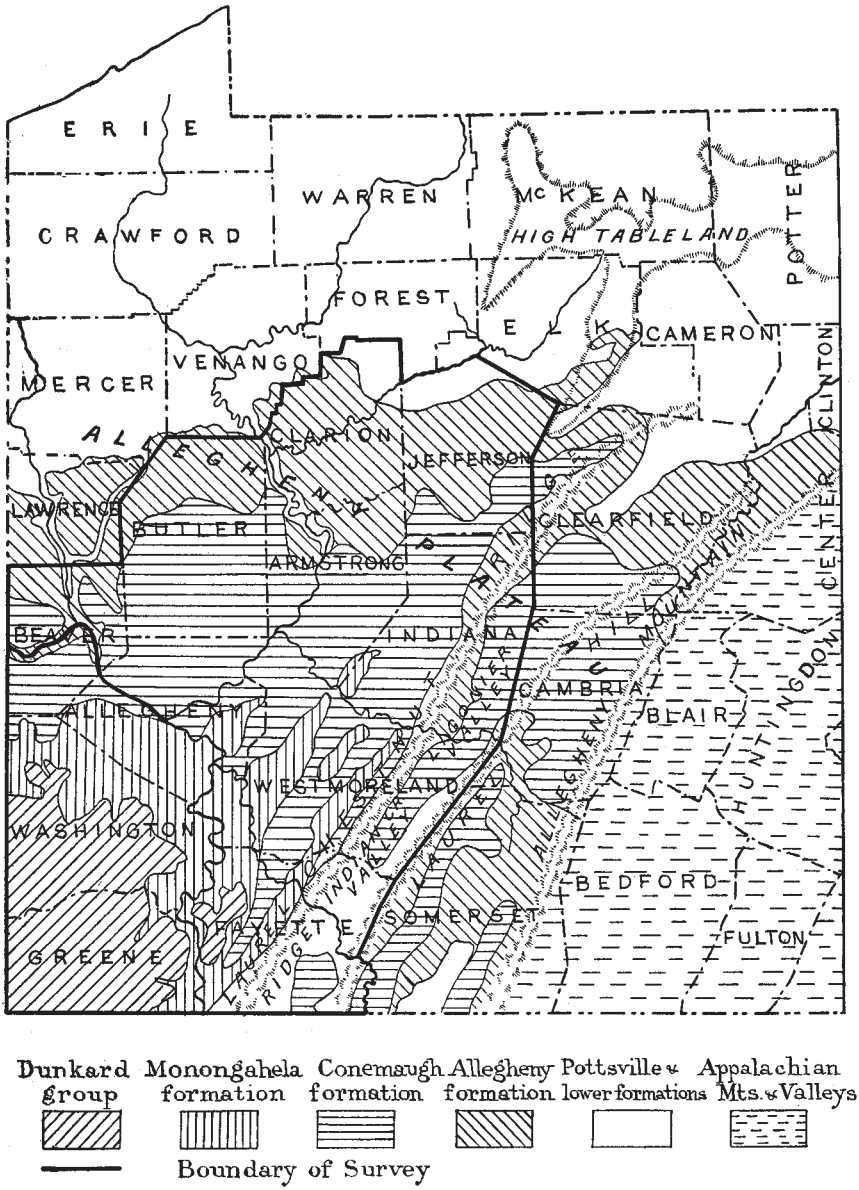

FIG. 2.—Sketch map showing the principal divisions of the Allegheny Plateau and the Appalachian Mountains and Valleys section, and the areas in the former occupied by the different geological formations.

of hills and ridges, many of which are steep-sided. From the hill tops, however, the outline of an ancient upland plain is at once

apparent, an imaginary plane connecting them marking a surface tilted to the northwest wherever the view is extensive, but where the view is restricted a locality may appear to be level or nearly so. Dissection is deepest in the eastern division of the area surveyed, but there are many localities in the western or main division where it is also a serious factor from the agricultural viewpoint. In addition to the surface configuration caused by erosion, some corrugations or folds due to lateral pressure of the earth's crust appear at present in the form of low, narrow, parallel rolls or swells which may extend for considerable distances. These mark a succession of anticlinal and synclinal folds which in some cases suggest a wavelike roll of the general surface, yet when more pronounced cause sharp breaks in the local topography. With the exception of Laurel Hill and Chestnut Ridge the steep areas are caused almost entirely by deep trenching of the original plateau surface, and are not due to true ridge formations.

The area mapped, then, is a part of the lofty plateau which descends gradually westward and northwestward from the crest of the Allegheny Front to the Ohio River and Lake Erie, and lies entirely within the Mississippi Valley region. Of this important highland the topographic variations already mentioned are local characteristics.

A third line of main elevation assumes prominence in the northeastern part of Jefferson County along the Clearfield County line. It constitutes a high table-land generally parallel to Chestnut Ridge, extends across Elk County to the northwest corner of Cameron, and thence spreads into a still broader high table-land across McKean County to the west and Potter County to the east. A local hill in the latter county so divides local drainage that a part flows through the Susquehanna River to the Atlantic Ocean, a part through the Genesee River to Lake Ontario, and the rest through the Allegheny River to the Ohio. All the northern part of the area mapped in 1909 is drained by the Allegheny and its numerous branches.

The geological floor of this plateau consists of sandstones, shales, limestones, and sandstone conglomerates, all of Carboniferous age. These materials were all horizontally placed originally, but later so tilted as to give the present gradual slope westward. Variation in the hardness of the rocks and their consequent resistance to weathering agencies shaped the course of drainage and brought about the present uneven surface characteristics of the region. Wherever massive sandstones and sandstone conglomerates form the surficial rocks from which the soils have been derived, the highest parts of the region are found at present in the form of mountains, ridges, and hills. The limestones, shales—especially the limy shales—and thin-bedded sandstones have weathered more rapidly, and thus formed

the lower levels of the plateau, where the soils are deeper than on the hills. It is from these rocks that the principal part of the farm lands of the Allegheny Plateau have been derived.

When the whole region is viewed in perspective the extent to which erosive processes have taken place is striking. To the casual observer the very thinness of the soils would indicate high resisting power to erosive agencies. The steeply worn, yet rounded, slopes, moreover, which seem to stretch for long distances in some cases, and in others the deep and sharp incisions which may form a succession of V-shaped valleys or gorges with intervening ridges ascending to a sharp apex, give the appearance of a most diversified surface, which frequently becomes sternly rugged. Such surface features indicate that tremendous erosion has already taken place, and local conditions show that the same process is still going on at a rate most serious to agriculture.

The shales, limestones, sandstones, and coals form a series of superincumbent layers which enter the State at the southwest corner with sufficiently sharp upturn to cause the edges of the different formations to outcrop sooner or later, the upper members soon disappearing, while the lower members of the column successively appear on the surface and determine the soil derivation.

Following in part the old-established names used within this region by the Pennsylvania Geological Survey for the geological formations early identified, and in part the names given by the United States Geological Survey to formations and finer distinctions later worked out by them, the members of this series of geological laps are called the Dunkard, Monongahela, Conemaugh, Allegheny, Pottsville, and, lastly, several lower members, which have been grouped as "Formations below the Pottsville."

Of this group the Pocono is one of the upper members, and, although of little importance in soil formation in the southwestern part of the State, because so covered as to appear at the surface only in deep stream cuts, farther north along the northern limits of Jefferson and Clarion counties it caps remnants of the old high plateau level or appears as an outcropping plane at lower elevations on their slopes.

The Allegheny, Conemaugh, and Monongahela formations correspond, respectively, to the Lower Productive, the Lower Barren, and the Upper Productive measures as described in the Second Geological Survey of Pennsylvania.

The Brooke soils have been derived from the Monongahela formation, which consists of limestone and limy shales principally, but also includes some thin-bedded sandstones.

The Westmoreland soils come from the Dunkard and Conemaugh formations. Of these the Dunkard differs from the Monongahela so far as soil formation is concerned, chiefly in that less limestone is

present, with a corresponding increase of shale; while the Conemaugh consists of a fine sandy shale with only a few thin beds of limestone.

The Dekalb soils have been derived principally from the Allegheny and Pottsville formations, which consist of shales, sandstones, and conglomerates. Hence these rocks are coarser in average texture than those from which the Westmoreland soils have been derived, and contain also more quartz sand and less lime. Where derived from a true conglomerate the sand is very light colored as seen in the field when separated by water from the finer soil grains. The percentage of limy shales present is lower than in the Westmoreland soils, but fine-grained sandy shales give rise to extensive areas of the Dekalb soils.

The Upshur soils, which are of little importance in this area, are derived from the Mauch Chunk and Catskill red shales.

The Volusia soils have been derived from glacial débris, and the small area of terrace soils associated with them constitutes the Genesee series.

The Jefferson soils are colluvial in origin. They are associated with the Dekalb and Westmoreland soils and consist of an accumulation from those soils along lower slopes and sometimes in semibench-like positions of U-shaped upland valleys. They represent a stage of soil formation intermediate between soils in place derived from upland sedimentary rocks and the true terrace soils. In many soil series of the East the topography and character of soil-forming materials is such that there is not enough colluvial material to constitute a distinct soil class. The type of erosion in the Dekalb soils of this region, however, necessitates such separation for the purpose of showing the relationship of these soils both to the Wheeling and to the true Dekalb soils. They differ from the Lickdale soils of eastern and central Pennsylvania in that they are well drained.

The second terrace soils of the Westmoreland, Brooke, and Dekalb soils have been classified as the Wheeling series, and the first terrace soils as the Huntington series.

The Kittanning soils owe their origin to an early high glacial terrace.

The first bottom lands associated with the Volusia soils have been correlated with the Genesee soils.

The presence within the area of the finest bituminous coal field as yet exploited in North America has led to the establishment of commercial industries unparalleled. The location of the Pittsburg vein of coal is shown in figure 3. This vein is not continuous in the region indicated, as much of it has been eroded away, but it occurs in areas so large that the supply has often been described as inexhaustible. Campbell states (U. S. G. S. Folio No. 82) that "the Pittsburg coal is a first-class steam, gas, and coking coal, which constitutes the greatest source of mineral wealth in southwestern Penn-

sylvania. The Connellsville coke is considered the standard of excellence."

In figure 4 (also from U. S. G. S. Folio No. 82) is shown the general extent of the entire coal field of western Pennsylvania. This region contains many coal veins which outcrop at different horizons. All the others are thinner than the Pittsburg and seldom of as good quality, grading from nearly as good to very inferior coals.

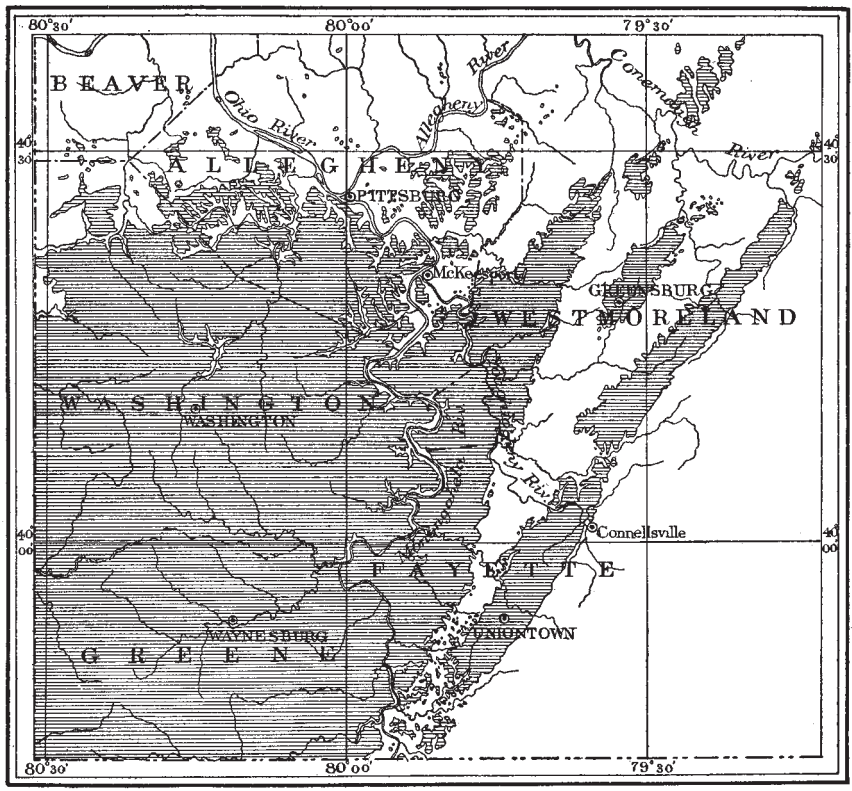

FIG. 3.—Map showing the area of the Pittsburg coal in Pennsylvania.

In many places within this area no workable coal occurs, and toward the edges of the coal field the veins are usually thin. To understand the present condition and development of the soils it is useful, in fact necessary, to bear in mind the location of the important veins of coal, their previous exploitation, and the probable trend of their mining in the future.

The plan adopted for soil descriptions in this report is to describe certain typical sections which are representative of the soil conditions as a whole. This, it is believed, will suggest a more comprehensive idea of the soils from a reconnoissance viewpoint than could a greater

mass of description designed to cover the conditions in all sections, as the latter would involve much repetition and defeat possibly the very aim of the reconnoissance plan.

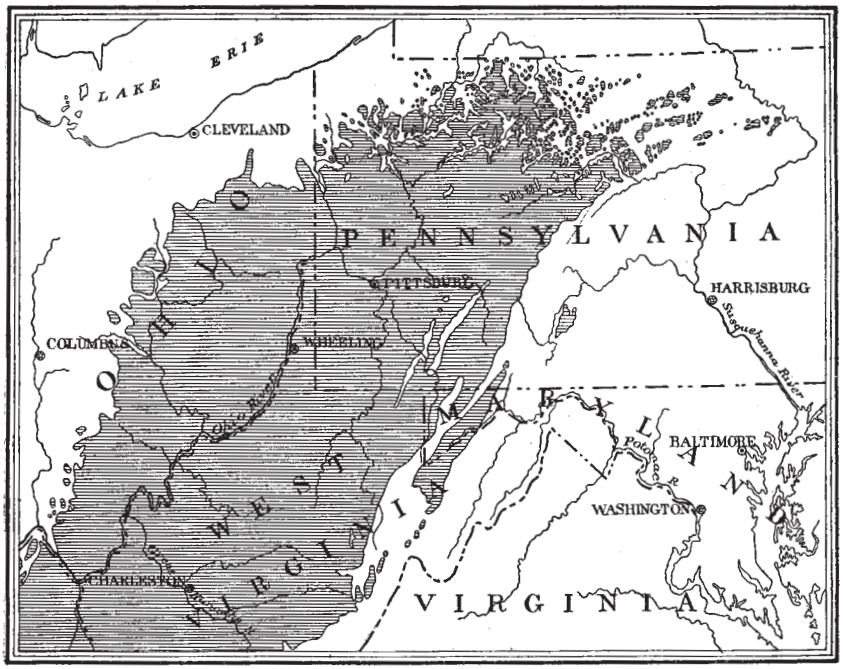

FIG. 4.—Map showing the extent of the northern part of the Appalachian coal field.

The following table gives the names and areas of the several soils shown in the accompanying map:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Westmoreland soils	2,453,184	48.4	Jefferson soils	10,944	0.2
Dekalb soils	2,074,752	40.9	Kittanning soils	9,216	.2
Brooke soils	312,768	6.2	Genesee soils	3,456	.1
Wheeling soils	107,712	2.1	Upshur soils	576	.1
Huntington soils	48,384	1.0	Total	5,063,040	.....
Volusia soils	42,048	.8			

UPLAND SOILS.

DEKALB SOILS.

The Dekalb soils include all the uplands of Jefferson and Clarion counties, the greater part of Indiana and Armstrong counties except near the Conemaugh River, where replaced by the Westmoreland

soils, eastern and northern Butler, and the eastern parts of Fayette and Westmoreland counties, excepting the Ligonier Valley. This area of 3,241.8 square miles of Dekalb soils adjoins that of 4,602 square miles of the same soil series mapped in 1908 in the Reconnoissance Survey of Northwestern Pennsylvania, and with it forms the dome of the great highland area of the western part of the State. The soils included in the present survey lie high up on the westerly slope of the dome, and while including none of the summit proper, not extending quite far enough east for that, they occupy many lofty table-lands, some of which are nearly as high as the summit itself. These represent fragmentary surface areas of the old high plateau, separated from each other by deeply dissected gorges and V-shaped valleys where the true conglomerate and hard sandstone rocks are of great thickness, but with much less severity of outline where the shales predominate. In the latter case the slopes are more gradual, the young valleys much broader, and not infrequently a broad shoulder extends from one of the walls to the stream which lies at or near the foot of the opposite wall. When the stage of topographic weathering has progressed one step farther there may be a narrow area of recent alluvium on either side or possibly on both sides of the stream. The latter condition, however, is not characteristic of the Dekalb soils, as the alluvium of recent deposition usually shifts from one side of the stream to the other, and very often such change of location is frequent.

The drainage waters from the Dekalb soils are usually of rapid current, and sediments are washed with celerity to the lower stream courses, which in most cases are beyond the limits of the Dekalb soil areas.

In the northern part of Jefferson and Clarion counties the Dekalb soils have been derived principally from the conglomerate sandstones and shales of the Pottsville formation, while in stream cuts sandstones and shales, including the Pocono of a lower horizon than the Pottsville, have had some slight effect on the derivation of these soils. In the central and southern parts of the Dekalb area the soils have been derived from the Allegheny formation, so named from the river of that name, along which it typically occurs. This formation consists of sandstones, shales, and occasionally small amounts of limestone, but the latter are so deeply covered that they have had no appreciable influence on the formation of the soils. The Allegheny formation immediately overlies the Pottsville, and in the report of the State Geological Survey was referred to as the Lower Productive measures.

The horizontal or only slightly tilted position of the rocks from which the Dekalb soils have been derived has left the edges of these rocks at or very near the surface on the steep slopes, a condition giv-

ing rise to varying degrees of seepage which are correspondingly injurious to crops.

Outcrops of these shales and sandstones are not infrequent on the sharp slopes where erosion has been severe, and in such case very wet pockets occur unless there is sufficient lateral tilt of the rocks to carry away the excess of drainage waters. The only other poorly drained areas of any importance in the Dekalb soils are on flat uplands, where the underlying solid rock is not sufficiently tilted to allow lateral drainage. Such areas may be too wet for any practicable crop production, but they include only a small part of the Dekalb soils. They require mention, however, for such soils should be avoided by those looking for farms. The Dekalb soils as a series are well drained.

It will be readily seen that the problem of local transportation under such topographic conditions as have been described is somewhat serious. Not only is the haul between farm and railway station difficult in many cases on account of hilly roads, but hauling on the farm often necessitates steep grades, thus lessening in marked degree the amount of work that can be accomplished with a team. Careful management makes the best of these conditions and loses only a minimum of efficiency, but considering the present cost of labor and the constantly increasing expense of team maintenance, the consequent problem of nonproductive energy on the farm is a factor which needs careful adjustment.

The surface color of the sandy types of the Dekalb soils is yellow, light-brown, or gray, while in the loams and heavier types brown and yellow are the prevailing colors, though dark steel-gray is sometimes found. Where derived from coarse-textured sandstones and conglomerates the white or very light-colored medium and coarse grains of sand give a light-colored appearance to the surface soil. Such areas are of less extent than those mentioned in the reconnoissance report of 1908. Most of the derivative sandstones and shales are fine textured and give the characteristic yellow-brown color of the Dekalb soils. Fields well farmed have a darker brown color than is typical, because of the presence of greater amounts of decayed vegetable matter. This change of color is a visible indication of a soil condition more productive than is typical, and will be referred to later under suggestions for soil improvement.

The subsoils of the Dekalb soils are typically yellow or light-brown, but there are many local areas having a slightly reddish tinge, and occasional spots of yellowish-red. Where poorly drained, gray and pale yellow mottling occurs; but such conditions are rarely found in areas at all extended.

A brief description of the prevailing Dekalb types of this area follows:

The surface soil of the Dekalb fine sand consists of 6 to 10 inches of fine sand, of which the color is varied more or less by organic matter, underlain to a depth of at least 30 inches by fine sand of original color above defined.

The surface soil of the Dekalb fine sandy loam consists of fine sandy loam from 8 to 12 inches deep. This may be underlain by clay loam or sandy clay, or between the two there may be a layer of yellow sandy loam.

The surface soil of the Dekalb loam consists of a silty loam from 10 to 15 inches deep, which grades into a silty clay loam subsoil.

The surface soil of the Dekalb silt loam consists of a silt loam from 10 to 20 inches deep. The subsoil is a silty clay loam, which sometimes grades into a silty clay below a depth of 2 feet.

The surface soil of Dekalb clay loam consists of a silty clay loam from 6 to 12 inches deep. The subsoil is a heavier silty clay loam, which often grades into a silty clay.

Fayette and Westmoreland counties.—The Dekalb soils in Fayette and Westmoreland counties occupy Chestnut-Laurel Ridge and Laurel Hill, which inclose the Ligonier Valley as it extends from the Conemaugh River nearly to the Youghiogheny, and also the entire southeastern part of Fayette County. South of the Youghiogheny River these parallel ridges are not so prominent as north of that stream. They appear more as local divides and in places tend to merge into a high plateau, the surface of which is so broken, however, that plateau characteristics are seldom observable except from some point affording an extended view across the region. The tops of these ridges in the southeast part of the county as well as north of the Youghiogheny are stony, and Dekalb stony loam extends for a considerable distance on each side of them. Large flat table rocks and ledges form many local areas of rough, stony land.

On the ridges and hills the soil is largely fine sandy loam. In the Farmington district loam predominates, but there are local areas of both the Dekalb clay loam and the Dekalb fine sandy loam. On the sandstone ridges the soils are shallow, but on the more level shale areas the soils are 3 feet or more deep and bring good crop yields. Well-improved farms are not infrequent, and conditions are fairly prosperous.

In the southern part of Henry, Clay, and Wharton townships, Fayette County, between Big Sandy Creek and the Youghiogheny River, Laurel Hill merges into the general rolling plateau surface, and farming lands are more extensive than farther north. Along the Maryland line the surface is broadly rolling and becomes steep only

along the breaks to the streams. This represents a good district of Dekalb soils. For 2 to 3 miles on each side of the Youghiogheny River the surface is much broken, steep, and rough. The soils are also sandy. In Stewart Township, and in fact scattered among the Dekalb soils of the county, there are patches of red soils which belong to the Upshur series, but they are not of sufficient area to be shown on the accompanying map.

Indiana County.—Banks and Montgomery townships, in the northeastern part of the county, have the local reputation of being a good farming district, and they are illustrative of a considerable range of Dekalb conditions. Good agricultural soils extend over the major part of these townships, but interspersed with them is a very considerable percentage of rough and steep land adapted to forestry only. In fact, a succession of lofty knobs gives the key to the topographic character. These knobs are often steep, but smooth shoulders not infrequently occur and give the most favorable locations for farms. The prevailing soil type is perhaps the silt loam. For such soil the local designation is "clay loam" or "clayey ground," as distinguished from sandy soils. Not infrequently the clay content is sufficient for that classification, but silt is usually present also in sufficient quantities to be the determining factor in giving character to the soil.

Silty fine sandy loam is interspersed with the heavier types. Some farms are also located on broad hilltops, but there the soil is likely to prove more sandy.

These townships are underlain with coal, for which the present market price is about $40 an acre. The price of fairly well improved land without the coal is $20 to $40 an acre, including buildings. Hence some farms can be bought to advantage. The soil conditions in Canoe, Grant, East Mahoning, North Mahoning, West Mahoning, South Mahoning, and Washington are similar in range to the northeastern townships, except that the percentage of rough land is a little less. The region is divided into tilled fields, pasture, and woodland in approximately equal proportions, and in many cases individual farms are similarly divided. Good farming communities of three to a dozen farms are fairly frequent, but are separated from each other by tracts of similar size where the topography is much broken.

All farms containing as much as 100 acres, and most of the smaller ones also, have some rough land, but as a whole the land is not too rough to support good farming, though many individual fields are cultivated which on account of steepness should not be so managed. Such fields should be maintained in pasture or left in timber.

The land is reasonable in price, except near the small villages, where it is sometimes too expensive, considering the soil conditions and advantages of location. An average price of farms is $30 to $50 an acre, but if the poorer farms are eliminated from the average very

good farms range in price from $40 to $60 an acre, including the coal. Without coal the same farms would be sold for $25 to $35 an acre. Where the coal has been removed, however, the farms are often worth only $10 to $20 an acre, depending on the extent of the injury done, or believed to have been done, by the removal of the ground water.

From Smicksburg west to the county line in West Mahoning Township the prevailing soil type is the Dekalb fine sandy loam, which is not very well farmed, but from Smicksburg south along Little Mahoning Creek to Rossmoyne is an excellent farming region. These soils are largely silty loams and silty clay loams, and by drifting into low slopes just a little above local stream levels limestone is quarried. The limestone is in most cases thin-bedded and as it is easily quarried and coal for burning it is very cheap and convenient, lime for agricultural use is easily secured. Where there is no local supply of lime, or it is too far distant to haul by teams, it is shipped in from Center County at an approximate cost of $3 a ton for the burned lime. The uplands of Washington Township and the northern or Dekalb part of Armstrong do not differ in soil range from the Mahoning townships. Both present good farming conditions, but there are many rented farms, some of which are in very poor state. In fact, one is impressed by the neglected and deplorable condition of some of the good farms.

In the narrow valleys of Crooked Creek and of Plum Creek the soils, which are largely silty loams and silty clay loams, are prevailingly good. Yet of these some are well farmed and others are not.

The narrow valley extending from Indiana to Gaibleton through central Rayne Township includes many productive farms, though there are also a good many steep fields reaching back onto the hills on either side. With increasing distance east the farms become steeper and steeper until fields are tilled which seem far beyond the limit of profitable working. Such fields are included, however, in farms which present a very thrifty appearance and bear testimony to the productivity of the soils, which are largely silt loams. It is believed, nevertheless, that the steepest of these fields should have been left in permanent forest and that those now cleared should be used as pasture. If seeded to pasture grasses and then periodically limed, harrowed, and fertilized they should yield better returns than is possible under a system of tillage at the present and probable future level of labor cost. When tilled, too, these soils suffer severely from erosion.

Green is an excellent farming township, except for a strip along the east side, where the topography is much broken and the soils are more or less sandy. These conditions extend eastward to the Susque-

hanna River in Cambria County. West of Beringer, Spruce, and Grip, Green Township as a whole is gladelike, but includes many local topographic irregularities. The soils are principally silty loams, with small areas of silty fine sandy loam and heavy silt loam.

Fifteen years ago a good average farm sold in this region for $25 an acre, including coal. Now the coal is considered worth about $50 an acre and practically determines the price of land. Sometimes the land is even included in the acre price for coal, but in other cases it adds slightly to the present valuation.

In the southeast part of the county Chestnut and Dias ridges, which occupy the main part of the two strips of Dekalb soils that occur there, are largely nonagricultural. Much of the soil is a stony sandy loam which supports some stage of forest growth. Along the lower slopes of the ridges and on local shoulders there are some farms, but most of them are only fairly productive. Pine, Buffington, and East Wheatfield townships are mostly rough; in fact, little of the land along the whole eastern boundary of Indiana County is adapted to cultivation. The greater part should be in forest, though local areas are not infrequent which are suitable for permanent pasture, and fairly good farms are occasionally found.

Armstrong County.—Entering this county near the northwest corner, the Allegheny River flows in a tortuous course southeast to Mahoning, thence southerly to Rosston, and thence to the southwest corner of the county. At the latter point it receives the waters of the Kiskiminetas River, which forms the southern boundary of the county and likewise of Indiana County on the east. At Rosston it is joined by Crooked Creek, at Gosford by Cowanshannock Creek, at Mosgrove by South Fork of Pine Creek, at Mahoning by Mahoning Creek, and at Redbank by Redbank Creek. All these important streams enter the Allegheny River from the east, Redbank Creek being the main drainage system of southeastern Clarion and all the central portion of Jefferson county, while the southern part of the latter and the northern part of Indiana County are drained by Mahoning Creek.

In the central part of the county terrace soils of importance, though not large in extent, occur along the Allegheny River. Otherwise the stream courses are for the most part deeply cut, and not only are terraces wanting, but there has been little opportunity for the formation of any considerable areas of the Jefferson soils. The main streams are deeply trenched, and so cut the county into sections to a considerable degree, as the valley walls are usually sharp; but the branches and streamlets which form the secondary drainage have not worn their courses so deeply as in many Dekalb areas, except near their junction with large creeks. This gives a fairly uniform upland topography, with soils deep enough in most cases to be desirable for

cropping, and agricultural conditions are generally attractive. In perspective the surface may be described as a smoothly sculptured plateau, moderately rolling, and including a succession of well-rounded hills, marked here and there by a steeper and more resistant ridge-like elevation formed from rock materials more resistant to the agencies of weathering than were those of the smoother areas surrounding them. Notwithstanding the smooth contours of the region as a whole, both roads and farms are more or less hilly. Many of the hills are broad and dome-shaped, so that the farms contain not more than 20 per cent of land too steep for profitable and advisable tillage. The rough areas follow the sharp little gorges which ramify the region and include also some steep and rocky little knobs. All such are forested and this gives a striking appearance of field and small forest to the region, making it very picturesque, while the smoother lands are attractive from the farming viewpoint.

The soils in Reyburn Township are largely loams with spots of clay loam and silty fine sandy loams. Crossing Valley Township from west to east the fine sand content increases until in the eastern part the fine sandy loams probably exceed the loams in area. Farmers generally speak of the soils as sandy, but this is undoubtedly due in large part to the presence of fine sand and local gritty areas, which tend to obscure the relatively high percentages of clay and silt. These are good soils and farms of 100 acres, including some broken land, but with pretty good improvements are well worth for farming purposes the price asked—$5,000 exclusive of coal rights. In Cowanshannock and Wayne townships loams and heavy loams prevail, clay loam areas being rather more common as variations than sandy loams. These should be good farming townships, but on the whole the soils are not kept up to as high a degree of production as they might well be, and most of the farms are too large. Limestone may be dug very cheaply, even if not located on any particular farm, and its presence means much to agriculture in this section, though not nearly enough is used. Land prices run from $20 to $60 or more per acre, according to improvements. If a farm has been well kept up, it will bring $50 with only moderate buildings, while land in not above moderate condition with mediocre buildings is held at $30 to $40 an acre, and well-improved farms, nearly all of smooth land, are worth $60 to $70 an acre.

The Dekalb soils of Kittanning and Plum Creek townships constitute a good farming district. The soils on the rounded hills which make up the principal part of the tilled lands average a loam, though small, steep hills and knobs are often sandy. The lower slopes are too steep for economical tillage, and severe showers in the crop season sometimes cause very destructive washing on such fields. Good farms average about 100 acres in size and range in price from $50 to $75 an

acre, including the Freeport vein of coal, which is considered worth about $30 an acre in this region.

In Manor, Bethel, Gilpin, North Buffalo, and South Buffalo townships there is a good deal of broken land, but back from the Allegheny River such areas are interspersed with good farming districts. Some of the hilly and rough lands are too sandy—the Dekalb fine sand and fine sandy loam—for the profitable maintenance of a good pasture sod, and should be left in forest; but the stronger soils are well adapted for permanent pasture. In this district several abandoned farms were seen, and many semiabandoned ones. Most of the former should have been abandoned, and some of the latter are hardly worth bringing back into shape, but generally these farms are worth restoring to a productive condition and many of them offer good opportunities for so doing.

Along the southern Armstrong-Butler county line, in the Buffalo townships of each county, the smooth hills are well farmed. The soils are principally loams, silt loams, and clay loams. Farms range in price from $30 to $60 an acre, but $40 to $50 is an average price of desirable farms.

In the other western townships of the county the loam and silt loam soils, west of the broken lands along the Allegheny River, support a thrifty agriculture. It is the same hill-and-dale type of country previously described, where good farms are often separated by stony hills or steep gorges, both forested. While pleasing to the eye from a scenic and artistic viewpoint, the farmer thinks of the handicap which these steep grades force upon him by expensive hauling. Along the western side of this county and the eastern side of Butler County there is a high district of poorer and more sandy soils.

Butler County.—In the eastern tier of townships in Butler County the Dekalb fine sandy loam is the prevailing soil type. On hilltops and where the topography is much broken, as it generally is, the soil is usually a thin, fine sandy loam, but where the topography is more smooth and the hills dome-shaped the presence of silt is sufficient to change materially the character of the soil and its productiveness. Most of this soil is a very heavy, silty, fine sandy loam. Much of it is excellent for potatoes and yet is poorly farmed in great part or even idle. Erosion has injured the soils in frequent locations. On sharp slopes the original soil has been so eroded since the forest was removed that the subsoil is now exposed or slightly covered. The subsoil is usually a fine sandy clay, or clay loam. From St. Joe to Parker Landing, following the course of the railroad, soil dissection is deep, farm buildings are in poor condition, oil wells command the interest, and thrift in things agricultural seems remote.

The Dekalb soils in northern Butler are generally sandy and closely resemble the soils of southern Venango County, described in the

Report of 1908. The northern half of Marion and Venango townships and also Cherry Township have sandy soils and much broken topography.

Average farms range in price from $15 to $35 an acre. Some good farms are found in scattering saucer-shaped areas of silty loams and can be bought at $40 to $50 an acre, while farms along a pike are sometimes held as high as $100 an acre, though they are not worth it for farming purposes. Farm prices are often scaled not for their intrinsic value, but in accord with what a better farm in the locality has been sold for.

From Branchton to Hilliard and Argentine, a strip from 2 to 4 miles wide along the Bessemer and Lake Erie Railroad is steep and broken, and the soils are usually sandy. This is probably the largest area of this sort in Butler County, though there are many local areas of similiar character.

The Dekalb soil region in Butler County is much poorer than that occupied by the Westmoreland soils. Farming on the former is not popular, almost any kind of job being considered preferable. Many local areas are somewhat deeply dissected and unsuited to farming, but there are also many gently rolling areas now producing almost nothing, which with efficient management would be productive.

Clarion County.—Crossing this county from northeast to southwest the Clarion River is the main channel of dissection and drainage and flows into the Allegheny River. Red Bank Creek forms the southern boundary of the county, runs parallel to the Clarion River, and empties into the same stream. All these streams are deep cut, V-shaped, and have precipitous banks. Bottom lands even of small area are rarely developed. The valley walls are rugged and steep, even to severity. The main tributary branches for some distance back from their junction with these streams—i. e., 2 or 3 miles or occasionally more—are also deep cut, the valley walls being steep and angular. Hence the county for 1 to 3 miles from the main streams and relative distances from the tributary streams is essentially nonagricultural. It is now in forest and should so remain. An exception to this classification is the Licking Creek Valley, which is trough-shaped. The heavy silty loam and silt loam soils of this valley belong in the Jefferson series, but do not so appear on the map, because it had not been decided to separate that series when Clarion County was mapped.

Barring the rough lands along the Clarion River and Red Bank Creek, all the higher plateau section lying between these two streams is a good farming country. About one-half of this region consists of level or gently rolling remnants of the old plateau surface, and these are covered with deep soils. These level soils do not occur, however, in large tracts. To illustrate, an excellent 200-acre farm

contains 100 acres suited to profitable tillage, 50 acres sufficiently steep to be used as permanent pasture to best advantage, and 50 acres in woodland, most of which is better for that purpose than for pasture. Between groups of such farms considerable areas of deeply cut and hilly lands are left principally in forest, though in small part pastured.

In this region loams, silty loams, silt loams, and clay loams predominate and are good agricultural soils, although fine sandy loams are frequently found, and in some cases loamy fine sands.

The soils north of Clarion River are lighter and, generally speaking, less productive than those south of that river. The plateau surface is quite broken and the hills rather steep. The soils are the fine sandy loam and the silt loam, the former including local areas of fine sand, also of fine sandy and silty loams. These two main soil divisions occur on the general plateau level in alternating strips of considerable width, though on slopes the soils are more mixed. Where fairly smooth the soils are in large part farmed, the silt loam much more so than the sandy loams. Of these types the character of farming is much more stable and profitable on the silt loam. The extent and proportion of the sandy soils increase toward the north and northwest county boundary, until the sandy soils predominate in the townships bordering on Forest and Venango counties. While perhaps less pronounced, the proportions of sandy and silty loam soils north of Clarion River are nearly the reverse of those south of that stream. This condition is more marked near the north and northwest county border than in the Shippenville region.

Because of the above soil occurrence it will be seen that these counties contain a smaller proportion of sandy soils than the adjoining Dekalb area included in the reconnoissance survey of the northwestern part of the State in 1908, and are correspondingly better from an agricultural viewpoint. In fact, Clarion and Jefferson will be good agricultural counties when the timber, oil, and coal have been exhausted. Farmers are generally prosperous as such, regardless of the influence of the other natural resources, and the county gives good promise for the development of her soils in the future.

Limestone occurs associated with some of the shales in such amounts that it is cheaply available for all farm purposes. There are no limestone soils of appreciable area, though spots of such soils occur on slopes, sometimes near the top of a hill, but far more often on the lower slopes. These are reddish in color and are readily distinguished. Their exact location or absence is determined of course by the absolute elevation above sea level. The Westmoreland soils are also interspersed with the Dekalb soils, particularly in the central and southern parts, but not in sufficient areas for practical separation on the present map. In places the old plateau has been left by erosion in

shallow dished form. Such areas are usually silt loam or silty loams, constitute the best farmed areas, and if sufficiently extensive would have been mapped as Jefferson soils.

Land prices in Clarion are generally reasonable, except possibly near the county seat. Farms with good soils and well improved with buildings can be bought for $40 to $50 an acre, including more or less coal—a 4-foot vein or a 3-foot vein in part, and sometimes both. One excellent farm of 100 acres of tillable ground, 50 acres of pasture, and 50 acres of woodland, including both veins of coal, and with very good buildings, was for sale at $75 an acre. For this farm the present owner paid $50 an acre forty years ago. It is located 1½ miles from town. The average crop yields on this particular farm are corn 40 bushels (shelled), oats 40 bushels, and wheat 20 bushels per acre.

Jefferson County.—Soil conditions in Jefferson County are very similar to those in Clarion County. Red Bank Creek enters the county near the southwest corner and with its three branches, Sandy Lick Creek, Mill Creek, and Elk Run, drains most of the county. Clarion River forms part of the northwest boundary. The streams are deep cut, in most places leaving little opportunity for the formation of terrace or more recent alluvial soils.

In the north part of the county the soils are sandy. The road from Brookville north to Sigel, thence northeast to Melzer, and the northeast county line follows the dividing watershed between Elk Run and Clarion River. Both streams are deep cut and the land along them for a strip about 3 miles in width is rough and steep. From Richardsville to Melzer the section is so rough, stony, and sandy that it should be in permanent forest. These same conditions extend west toward Sigel also, but the latter town is located on a plateau level, fine sandy loam being the prevailing type. These soils might well be improved, but the oil and coal interests draw most of the laborers and very few like to farm. From a little south of Sigel, south to the broken lands north of Red Bank Creek, silt loam and silty loam predominate, but fine sandy loam frequently occupies the steep slopes and hilltops. Similar conditions obtain in the district between Kirkman and Warsaw, but southeast of this line and following Mill Creek nearly to Sugar Hill is another broken section. This in turn is succeeded by a good agricultural district extending from Emerickville to Rockdale Mills.

The soils in the southern half of Jefferson County are largely silty loams and silt loams that have been rather severely eroded, but the main lines of erosion have been somewhat dished. Within these primary topographic saucers is a succession of hills and a few ridges which have been pretty well rounded, and so are relatively smooth in contour. Many of the hills are dome-shaped, and on them are some good farms. The breaks adjoining are almost universally

steep—too steep for profitable farming, but it is astonishing to see how steep are some of the fields kept in cultivation. In bygone years of cheap labor they could hardly pay, and under present conditions such areas should certainly be in permanent pasture or forest. Yet many fields have been cleared within the last few years, and the process is still going on. This is feasible on smooth areas of good soils which adjoin fields at present cultivated, but it is exceedingly impracticable on many of the steep areas which have been or even now are being brought into cultivation. This calls attention to a grave inconsistency on the part of some who complain of the scarcity and high price of labor.

In the north part of both Jefferson and Clarion counties local supplies of limestone are scarce and are dug only near the bottoms of deep stream cuts. With increasing distance southward the lime deposits are buried less deeply, and lime is much cheaper. In the southern part of these counties limestone frequently outcrops on hilltops, and the present price of burned lime at Worthville is only $2.10 a ton, practically as cheap as a farmer can burn it himself unless he has exceptional supplies of fuel and labor. Fortunately, the use of lime in farm practice is more universal in Jefferson than in Armstrong, Butler, and Beaver. This is one of the encouraging signs of an improving agriculture. Farms can be bought near Worthville at $50 to $60 an acre, including coal, of which the present selling price is about $30 an acre. These prices include good improvements, with railroad through Worthville giving direct Pittsburg connection. These prices are representative for the better agricultural districts of the county, though farther from towns and railway connections prices are even lower. In this region there are many good opportunities to engage in farming.

Crop yields on the Dekalb soils range within very wide limits. On poor sandy mountainous areas methods are usually correspondingly inadequate and yields are low. For such areas no estimate is given. The average yields for the series as mapped during 1910 is somewhat greater than those for the northwestern part of the State mapped in 1909, primarily because the percentage of sandy and rough soils is somewhat less. There are no material differences in yields when corresponding types are compared. The danger to corn from frosts is a little less than farther north and this increases the average yield materially. The yield of corn ranges from 20 to 50 bushels, with an average yield of 30 bushels per acre; oats 15 to 35, averaging 25 bushels; wheat from 8 to 15 bushels, buckwheat 10 to 25 bushels, and potatoes generally from 40 to 150 bushels an acre, but with exceptional yields of 300 bushels. More thorough working, the adoption of better crop rotations as suggested in the chapter on Present Agricultural Practice, and efficient fertilization would not only increase these

yields materially, but also increase the profits. The soils are adapted to potatoes, hay, and in the northern part of the area to buckwheat. Farther south buckwheat does not fill as well and is less grown. The sandy types of soil are good for garden crops, and where markets are within reach there is good opportunity for this business. On the silty loams and heavy fine sandy loams potatoes can be grown with much success and should be a prominent money crop.

WESTMORELAND SOILS.

The Westmoreland soils adjoin the main Dekalb belt on the south and extend thence to the south and west boundaries of the State, except as broken by irregular areas of the Brooke and the terrace soils. They are the principal upland soils in the counties of Allegheny, Fayette, Washington, Greene, Beaver, and Butler, and are of importance in the southern parts of Armstrong and Indiana. These soils lie entirely on the westerly slope of the Allegheny Plateau, but never extend to the crest of the Allegheny Mountains, nor do they occupy the high folds parallel to that chief elevation, namely, Laurel-Chestnut Ridge and Laurel Hill. Other lower folds, of which Dry Ridge, in Westmoreland County, is one of the most important, are Dekalb, but have not been designated on the map.

Not including the principal mountainous areas of the region and lying a little lower on the broad plateau slope than the Dekalb series, the Westmoreland soils are, on the whole, less rough than those of the Dekalb district. Yet as the junctions of the main regional rivers are within the Westmoreland soil areas, and as these rivers have eroded their course with some severity, many steep though not necessarily high slopes are found along them, and extend far back toward the stream sources. This gives surface features much diversified and a considerable percentage of steep fields; yet interstream areas are often broadly rolling, and the soil series as a whole may be described as moderately rolling but including frequent steep areas.

Good surface drainage is afforded by the varied topographic features, and the texture and structure of the subsoils of the Westmoreland series are such that their drainage is adequate. A moisture supply favorable for crop growth is also maintained on the soils as a whole, though the sandy members of the series sometimes suffer from drought, especially in late summer. For this reason such soils are avoided for crops requiring a full season to reach maturity. The percentage of sandy soils in the Westmoreland series is probably somewhat less than in the Dekalb series.

The Westmoreland soils have been derived from a combination of shales, sandstones, and limestones. Many of the shales are calcareous or limy, and the sandstones are fine grained and usually thin bedded. In many places these different formations are so inter-

stratified or otherwise related that the soils are a heterogenous product, and again areas of the different geological materials are distinct, but so small in area that a separation of the resulting soils is impracticable.

The determining characteristic upon which these soils were separated from the Dekalb series is their lime content, and while there is not enough lime present to admit of their classification as soils of limestone origin, their superiority over the Dekalb soils in productivity, when viewed in broad perspective, seems probably due in great part to the presence of the lime, and in general they form a better class of farm lands than do the Dekalb soils. The geological names of the different limestones affecting the soils of the Westmoreland series as given by the United States Geological Survey (Bul. 249) are the Upper Washington of the Dunkard formation; the Waynesburg, the Benwood or Great Limestone (of which the upper member is called the Uniontown), the Sewickley or Fishpot Limestone, and the Redstone, all belonging to the Monongahela formation; and the Pittsburg, Elk Lick, and Ames or Crinoidal limestone of the Conemaugh formation. The shales and sandstones from which the Westmoreland soils have been in great part derived belong to the Conemaugh and Monongahela formations and the Dunkard group, except as relatively unimportant Dekalb soil areas derived from the Allegheny formation have been included, especially in Beaver County, for some distance southeast of the Volusia soil boundary. Within the Westmoreland soil area there are local areas of Dekalb soils which have been derived from pure sandstones and shales. Such areas occur principally in the Dunkard group of Washington and Greene counties, where a detailed survey would make it possible to separate them, as it would also to some extent throughout the Westmoreland series.

In the southwestern part of the area, but more particularly in Greene and Washington counties, some of the hills are so steep that "land slips" are common. These occur in the spring, when the rains and water from the melting snow so saturate the soil that coherency is destroyed, and great masses, often acres in extent, will slip down the slope. These slips rarely move more than a rod of two in a season, but where the land is "springy" they occur almost annually and cause much damage. Thorough drainage is the only practicable way to guard against or prevent this damage.

A brief description follows of the principal types of soil encountered in the Westmoreland series:

The surface soil of the Westmoreland fine sandy loam consists of fine sandy loam from 8 to 12 inches deep, underlain by clay loam, or fine sandy clay.

The surface soil of the Westmoreland loam consists of silty loam, rarely a typical loam, from 10 to 15 inches deep. The subsoil is silty clay loam which sometimes grades into silty clay.

The surface soil of the Westmoreland silt loam consists of silt loam from 10 to 20 inches deep. The subsoil may be a heavy silt loam but typically is a silty clay loam.

The surface soil of Westmoreland clay loam is a silty clay loam from 8 to 15 inches deep, which becomes heavier in lower depths and sometimes grades into silty clay.

Fayette County.—The Westmoreland soils of Fayette County are somewhat variable and present a considerable range in texture. In the western half of the county the clay loam is the prevailing type, constituting probably two-thirds of the series area.

In the remaining third of the Westmoreland part of the county heavy loams and silt loams and silty clay loams prevail. The subsoils are usually silty clay loams or silty clays for the types mentioned.

The principal local variations are hill tops, which are often more sandy than the surrounding soils, constituting in some cases fine sandy loams, but more often gritty loams, and slopes where erosion has removed the mellow surface soils and left exposed stiff silty clays and clay loams. The colors of the last after erosion and washing has taken place are light yellow, light red, rusty, or ashy as the case may be, and such exposed subsoils are of course unproductive, and will so remain unless erosion is stayed, cultivation resumed, and a state of good tilth effected by the incorporation of humus-forming material. West of Laurel Ridge, along the Maryland line, the Westmoreland soils are more sandy than the average farther north in the county.

The large areas of Westmoreland soils in the western half of the county are moderately rolling, with local steep slopes, hills, and ridges. Three-fourths, probably, of these soils lie suitably for tillage, while the other fourth would be better for pasture and woodland were it not for the fact that such areas are often so scattered that the only feasible plan is to include them with adjacent tilled fields. Small steep hills and breaks along streams are frequently large enough, however, to be left in forest. Silty clay loam, silt loam, and loam are the prevailing types, with many local areas of fine sandy loam, and occasional spots of fine sand on hills.

Land prices in Fayette County west of Laurel Ridge are generally high. This is due to the presence of coal, which is increasing in selling price each year. As a result the agricultural value of land has practically nothing to do with its selling price. In fact, very little land is sold except to coal-mine developers, individually or in companies, and once acquired by them it is not again on the market

until all the coal has been mined, and then much of it has been injured by the removal of the water through mine shafts, even if coke fumes are no longer injuring vegetation.

In the eastern part of Fayette County north of the Youghiogheny River and lying between Laurel Ridge and Laurel Hill is the Indian Creek Valley, so named from a creek flowing through it. This valley, which is from 6 to 10 miles wide, would be a broad shallow trough were it not for the effects of erosion, which has cut the surface so deeply that the "valley" is very hilly, even locally. These hills are dome-shaped for the most part. Sharp crests are few, and a view from either of the flanking ridges includes a succession of elevations with smooth upper contours. A drive through the valley, however, discloses the fact that it has been far more deeply dissected than a bird's-eye view makes apparent. The local subvalleys are mostly narrow, sometimes almost V-shaped, and thus the lower slopes of the hills of which the tops appeared domelike are sharply cut. As a result the roads are hilly, the soils wash readily, ledges of sandstone and shale are exposed, and these, with scattering rock fragments, make the roads rough.

The Indian Creek Valley is most hilly in its lower part. In fact, there is little agricultural land for 4 miles north of the Youghiogheny River. Around Normalville the valley is smoother, and good farm lands prevail. With increasing distance north of Normalville the valley grows better all the way to Jonesville, in Westmoreland County. A few miles north of Jonesville there is a drainage divide across the valley. From this divide the drainage is north to Ligonier, where it is joined by similar drainage from the north before flowing westward out of the valley through a break in Chestnut Ridge to form Loyalhanna Creek. The valley of the headwaters is called the Ligonier Valley, though only a continuation of Indian Creek Valley, except for the low drainage divide above referred to.

The soils of Indian Creek Valley include quite a range, but the loam, fine sandy loam, and silty loam are the prevailing types. Westmoreland clay and clay loam are less extensive than the silt loam, but all are of importance. These valleys have supported good farming communities, though only a moderate amount of stock has been kept. Colts now seem to be the most profitable form of stock. The most thrifty farmers sell garden produce at towns within driving distance. The soils are well adapted to such use, and a good living is obtained.

The Pittsburg vein of coal is said not to extend to the Indian Creek and Ligonier valleys. The thinner veins do, but their development has only just begun. As these veins lie deeper than the Pittsburg and are thinner, the land is not likely to fall in when they

are removed. The price so far paid for these veins in this district has ranged from $20 to $50 an acre, most of the coal now having passed into the hands of the coal men.

Good farms with deep soils and good buildings upon which improvements have been kept up are now worth about $50 an acre. Farms with thinner soils and less desirable buildings sell for $20 to $30 an acre. Both of these valleys offer good opportunities at present prices to buy farms for the purpose of growing vegetables and supplies for the mining towns which are certain to be there soon.

Westmoreland County.—West of Chestnut Ridge the Westmoreland soils are mixed with the Brooke soils, both forming a steeply rolling to hilly region similar to western Fayette, but not quite as hilly as Washington and Greene counties. The soil types range from a sandy loam to a clay, but the prevailing types are the silt loam, the clay loam, and the loam, with the clay loam and the clay on the steep slopes, where erosion has in part removed the surface materials.

Indiana and Armstrong counties.—The Westmoreland soils occupy only small areas in the southern part of these counties, and there the soil descriptions already given cover the conditions. In general the interstratified limestones are deeper covered with distance northward until their influence upon the soil becomes negligible, and the latter are succeeded by the Dekalb soils. Farms with very good improvements in the Westmoreland section can be bought for about $40 an acre.

There are local synclinal valleys with good soils that are capable of supporting a thrifty agriculture that offer good opportunities for farming investment; that is, intelligent farming will afford a good living. There is lack of uniformity in land prices nevertheless, as some farms can be bought cheaply, while others are held at or above full value. Hence good judgment is essential in purchasing farms.

Washington and Greene counties.—In Washington County silt loam and loam of the Westmoreland series predominate, with some clay areas on steep slopes where erosion has removed the surface soil, and also a silty clay and silty clay loam in some of the local depressed or flat areas.

In Greene County silt loam is the most general type of soil, with fewer loam but more clay areas, due to the increased hilliness. There are also many local areas of lighter soils. About Racine, in the northeastern part of the county, occurs a flat upland locally known as "Sandy Plains," where the soil varies from a loam to a sandy loam, the latter being the more extensive. This area is devoted more largely to potatoes than any other part of the county, and some fruit is grown.

In southwestern Greene County, almost on the Pennsylvania-West Virginia state line, there is a long, narrow ridge, made up largely of sandy loams. This is located in one of the gas and oil regions, where most of the efforts of the inhabitants is directed toward developing those resources instead of agriculture.

South of the West Newton-Mount Pleasant pike, between Mendon and Ruffsdale, occurs another ridge of coarse-grained sandstones, giving stony sandy loams, stony loams, and sandy loams. The greater part of this region is in woods or pasture, only the smoother portions being cleared and farmed.

Smaller areas of sandy loam or stony sandy loam occur here and there, but they are too small to locate on a reconnoissance map.

In Washington and Greene counties, particularly in the western half, there are scattered areas of soils derived from red and red-brown shales. These soils are brown or yellow at the surface, while the subsoils range from reddish yellow to red in color, and belong in the Meigs series as mapped in the adjoining Wheeling and Middlebourne areas in the northern panhandle of West Virginia. These soils are best developed in the southwest part of Greene County, where they occupy the slopes of most of the hills, though the tops and bases of the same hills are occupied by the Westmoreland or Dekalb soils. Thus the Meigs soils, of which the clay loam is by far the most important type, occur principally as a band around steep hills or along ridge slopes.

The Meigs soils erode badly, and for that reason and because of their "hard" nature they are not generally farmed, but are usually in grass or pasture.

The principal areas of the Meigs soils are found in the southwestern part of Greene County and are included in the region indicated on the map by broken diagonal lines, which serve a double purpose, however, by indicating a much broken topography. Throughout the region thus outlined the stony loam and the shale loam, including many small patches of rough stony land, are the most common types.

There are scattered areas of Meigs soils in the Westmoreland areas of Washington County, the largest being near West Alexander. In Westmoreland County these soils occur in broken and scattered areas from Upper Burrell Township south, being found in the hilly region east of Sardis, near Export, near Boquet, near Launer and Rillton, and on toward Centerville and Macbeth. Scattered areas also occur near New Derry and Alters, where they generally occur on steep slopes in the Westmoreland areas, and are treated much as are the Westmoreland soils.

Allegheny County.—The severe erosion which has taken place in this county incident to the confluence at Pittsburg of the main streams

of drainage from the Allegheny Plateau forming the Ohio River, makes the topography of Allegheny County almost unique, even among the surrounding group of counties, though these also have suffered much from erosion. The main streams are deeply cut, yet wide terraces are a characteristic feature. These terraces have been of the utmost topographic importance in the development of this region, affording, as they do, the sites for many industrial towns. This feature makes these terraces of the highest economic importance, for the main slopes or breaks from the plateau level to the terraces are so abrupt that these are a great barrier to local transportation connecting with the main lines of railway along the rivers.

Back from the main streams much of the county is fairly honeycombed with the channels of secondary drainage, both major and minor streams. This leaves only a small percentage of the land sufficiently level for an economic agriculture, were it not for the fact that the proximity to stupendous markets makes the growing of garden produce and other food products feasible on lands so hilly that under other conditions they would not be cultivated to any appreciable extent. So far back from the main streams has the network of deep erosion gone that there are few large areas of gently to moderately rolling land until the boundaries of the county are reached.

In the southern part of the county limestone occurs in sufficient amount to form several areas of Brooke soils. Aside from these Brooke soils all the uplands of the county were mapped as the Westmoreland series. In the Pittsburg district the soils are derived from shales and thin-bedded fine-grained sandstones, both of which give rise to silty loams, silty clay loams, and silty clays. The latter are found principally where some of the surface soil has been removed by erosion. Coarser-grained sandstones occur and give rise to small areas of sandy loams. As far back from the main streams even as the north tier of townships there are few farms that are not hilly and most of them are very hilly. The intervening region is so deeply cut that all the land is on hillsides. Flat-topped hills are almost wanting, and where present are so small in area that they hardly form a feature of the landscape. While their tops locate relatively the old plateau level, they are so rounded off, conical, or pointed as to be much less suggestive of this ancient level than are the much broader areas of flat or dome-topped hills, ridges, etc., which have been described as a striking characteristic of the Allegheny Plateau as a whole. So pronounced is this erosion that even the northern tier of townships is not intrinsically worth more than one-half as much for agriculture as the adjoining southern tier of townships in Butler County, when the locations, except for the topographic differences, are considered as balanced.

North of an east-and-west line drawn through Pittsburg limestone does not occur in sufficient quantity to form the Brooke soils, but south of the same line the amount of limestone steadily increases. This gives rise at first to patches and appreciable areas of Brooke soils and then to important areas near the south county line. In Elizabeth and Forward townships the Westmoreland soils become secondary to the Brooke areas. In general the considerable areas of Brooke soils in Washington County split into fingerlike areas which extend into southern Allegheny.

Aside from the Brooke areas the Westmoreland soils occupy all the uplands except for local areas of Dekalb and Meigs soils, which have not been separated. In the region south of Pittsburg veins of limestone are frequent in the Westmoreland soil areas, occurring most often on steep slopes, where it is both underlain and overlain by shale. These veins occur at regular elevations above sea level, and hence outcrop at any point on the slope between the top and bottom, depending on the height of the local hill.

Owing to the fact that the limestone areas as geologically mapped are in part overlain by shales which have in the main determined the character of the soil formation, the resulting soils have in many cases been mapped as Westmoreland instead of Brooke. In Moon Township there is very little limestone except near Carnot, but in Findley and North Fayette townships there is a good deal. The local outcrops lie principally at an elevation of 1,140 to 1,180 feet above tide, and along the Steubenville pike through North Star, Fayetteville, Gayley, etc., there are many of them. In this part of the county the shales and limestones are much mixed and the rocks from which the Westmoreland soils are derived seem to be about two-thirds shale and fine-grained sandstone and one-third limestone. Silt-loam soils predominate probably, but severe erosion has continued to bring the silty clay and clay-loam subsoils near the surface until the different heavy types are well represented. Fine sandy soils are confined largely to hilltops, where sandstone rather than shale predominates.

There is, or has been, sufficient coal in Allegheny County to determine land prices, except as influenced in some cases by proximity to some important city or town. So great has been the effect of this unearned wealth upon many of the farm owners that things agricultural no longer appeal to them and they have removed to town. The farms have since been rented for a cash payment and practically no effort has been made to maintain their productivity. Farms of 100 to 150 acres are often rented at from $200 to $300 a year. The renter gets what he can, and moves in one, two, or three years. The owners hope to sell the farms for their coal or gas value and feel sure of doing so eventually. Such conditions lead to a minimum of interest in producing crops from the soil.

This is most unfortunate for the region and shortsighted on the part of the owners. There seems to be little excuse for the men who are occupying these farms not to maintain their productivity and to take advantage of the wonderful markets Pittsburg affords, thus making some money from the land until the coal is removed. On some of the farms in this district the land is being steadily and surely injured and destroyed by erosion and inadequate robbery farming. The tenants on rented farms are no more to blame for this than the owners. In the case of these lands there is public duty on the part of the owners, because the land will not only pay for its efficient maintenance, but a profit besides if well managed.

The farm buildings indicate the unquestionable coal-oil-gas attitude of " no repairs " and " no farming," but plenty of waiting for a good sale of lease rights.

Smoke from coke ovens and that arising from the concentration of industrial works in Pittsburg and surrounding towns has given to the landscape about these towns a gruesome aspect. Many of the hills are bare and practically devoid of trees. There is almost no tillage and yet almost no sod. In the places most affected vegetation is dead or dying, and everything is begrimed with soot and soft-coal smoke. These soils should be normally productive, but there is not a suggestion of anything agricultural within miles of some of the industrial towns, except garden patches of a few square yards or as many rods of onions, leeks, etc., which are fenced, the surrounding desertlike ground being tramped as hard as a board.

Butler County.—The Westmoreland soils in Butler County represent a good farming district. Much less dissected than Allegheny County, Butler has a very much higher percentage of land suited to tilled crops.

The southern tier of townships has few streams as compared with northern Allegheny County. The soils are loams, generally medium or coarse but rarely fine, while sandy types are found only in spots except on some of the hills. In Cranberry Township, however, the soils are more silty, and productive silt loams are found on parts of Glade and Brush creeks. In Jackson Township the topography is more broken than in Cranberry, the soils are more sandy, and the farming less remunerative. In Butler, Penn, and Jefferson townships silt loam is the prevailing type, while Franklin and Connoquenessing contain many more fine sandy loam areas, with a few local areas of fine sand.

In Lancaster, Muddy Creek, Butler, Center, and all the townships drained by Muddy Creek, loamy, silty soils prevail, affording many localities of excellent farms. Heavy and light fine sandy loams occur on some of the high hills and most farms have some of these types.

The most pronounced occurrence of sandy soils follows the divide between Connoquenessing Creek and Muddy and Little Connoquenessing creeks. This irregular area extends roughly from near Hooker to Unionville, Mount Chestnut, Whitestown, Buttercup, and Petersburg. These soils are much less productive than the loam, silt loam, and clay loam which lie between this area and Butler. The general prices of the latter range from $50 to $100 an acre, of the former from $30 to $70 an acre. On the low-priced farms many neglected fields, fences, and buildings are seen. Farms in the larger valleys such as the Connoquenessing and parts of its main tributaries sell for $100 an acre and even more as the distance to Pittsburg decreases. Farms 3 or 4 miles from Butler, a good town, but away from trolley lines can be bought at $60 an acre.

In the immediate vicinity of Portersville the shales and sandstones lie too near the surface for the soils to be productive, and for a little way south toward middle Lancaster conditions on sharp hills and slopes are similar, but nearing the latter village and thence toward Zelienople good soils abound though the surface is hilly.

In the county there are not infrequent semilowland areas. In elevation these are midway between a terrace position and the general level of the uplands. These soils have been derived apparently from shales that are more soluble and softer than the surrounding basal rocks. The lowest part of such dishing areas may be 50 feet lower than the upland rim, but their surface is often gently sloping. An area of this sort lays north of the railroad in Forward Township between Carr Station and Glade Run Station, another is found between Meharg Station and Brownsdale. The soil in this topographic position is largely a silt loam, but there are also frequent areas of a heavy silty fine sandy loam which is well adapted to potato culture and garden crops.

The Westmoreland soils of this county present a wide range of prices, which sometimes are according to their agricultural worth, but quite as often bear little relation to that factor. In one locality where farmers are prosperous farms of 90 to 120 acres are held at $30 to $50 an acre with very good buildings. Three-fourths of such farms are good for tillage, with the remainder in pasture and woods. These farms are more or less hilly, but vary much in this respect. In another district not far from the first a steep, hilly farm of 65 acres with a very good house and a fair barn is held at $5,000. It is worth about $3,000 for farming purposes. Another farm of over 200 acres is held at $15,000, though it is in poor condition as a result of a succession of tenants, and the buildings, which were formerly good, now need repairs, so that the farm is not worth nearly the price asked. Notwithstanding such examples farms in Butler County can be bought readily with careful selection as to soils, previous management,

location, and improvements at reasonable prices. This shows the absurdity of general land prices in the region. Farms that are not paying over 2 per cent interest on a valuation basis of $40 an acre are very often held at twice that price, and so yield not over 1 per cent, while still others bring in no interest and even then are deteriorating in value because of inefficient management. Unoccupied farms equipped with good buildings are frequently seen. Such conditions illustrate the lack of uniformity in land prices for equivalent values.

Beaver County.—Beaver County is divided into three parts by the Beaver and Ohio rivers. The former is deep cut and the land for at least a mile on each side of this stream, and often for 2 miles or even more, is rough and steep, the roads from the valley following up gorges. Yet good farms are not infrequent as soon as the top of the bluff is reached. The plateau level of Beaver County as a whole, however, is rather hilly and broken, though much of it is farmed. West of Beaver River and near Beaver Falls the fine sandy loam is the prevailing type, but the plateau top in Chippewa Township includes silty fine sandy loam, silty loam, and silt loam. For 2 miles south of Darlington toward Black Hawk and for 2 miles north of the last-named village the soils are sandy and not very productive, but between these two areas loams and heavy silty loams prevail. The topography is gently to moderately rolling, farm buildings and improvements are good, and the soils are farmed very well, though not intensely.

Around Black Hawk dissection is deep and the soils sandy, conditions not conducive to a prospering agriculture. Of other business there is little, and so population is decreasing. This district illustrates markedly the effect of good or poor soils on farm development. The eastern two-thirds of Brighton Township is an excellent farming region, but prices are rather high for investment in farm lands.

In southern Ohio and northern Industry townships silty loams and silt loam predominate. East Liverpool, Ohio, furnishes good markets for produce and all farm crops that can be grown in this locality. Near that town good farms sell at $100 an acre, but farther away and toward Ohioville very good farms range in price from $40 to $75 an acre. There is some oil and gas, and the region is underlain at least in part by a 4-foot vein of coal. This is a thrifty and prosperous community, and it illustrates in striking manner the importance of the factor of farm location. It is a vivid illustration of the wisdom of producing special products for special market demands, an adaptation with which general farming following the old well-established lines can not compete.

The east-central part of the county is another good agricultural section.

The location of several important towns on the river terraces, and the roughness of the topography immediately back thereof causes the nearest uplands beyond, where the land is even partly smooth enough for advantageous tillage, to be held at high prices. Roads from the terraces, or stream courses where the latter are wanting, follow up the gorges toward the general level of the uplands, which consist of a succession of knobs, rounded hills, grassy or more often wooded dales, dotted with well-kept farm buildings, the whole region being very picturesque. Such a zone is found in many instances where the uplands break to important streams. Drayage of all crops and manure in localities of this kind is expensive of both time and draft. Erosion is a very serious problem and should be carefully guarded against, yet neglect of its control indicates that the extent of its ravages is seldom realized by farmers.

The eastern half of Daugherty Township is held in much larger farms than that just described. Used for general agriculture, these farms can be bought for $100 an acre or less, including a thin vein of coal. At present prices these farms offer little inducement or opportunity to the buyer to make money in their management, but the prosperous look of the whole township shows strikingly the results of nearness to good markets, without being so near Pittsburg as to be above farming, to envy the suburbanite, and to ape urban customs and ideals.

North Sewickley Township is more hilly and steeper than Daugherty, the shale being so near the surface on the shoulders and breaks of hills and ridges, and often even on the tops thereof, that crops are susceptible to drought. The soils of the farmed areas are the fine sandy loam, medium and light silty loams, the last predominating. Marion and the northern part of New Sewickley townships are hilly uplands, somewhat deeply dissected. The soils are principally fine sandy loams, but small areas of silty loams are also numerous. This district is peopled largely by Pennsylvania Germans, who have made it a district of excellent farms, in spite of the fact that the surface is hilly and the soils rather sandy. This answers effectively the remark sometimes made that the notable success of these people in farming is due to the fact of their possession in large part of productive limestone soils. The soils of many farms in this district are naturally far below the average of the Westmoreland soils in this respect, and yet their product is far above that of not only the average of that series, but also exceeds that of many of the best soils.

If a group of individuals can accomplish such results there is no valid reason why the Westmoreland soils, well suited to farming, should not be made to pay adequate returns for capital and labor invested. The success of these men has been due in great part to good

systems of cropping, the adoption of modern methods in balanced feeding of stock, fertilizer study, hard work, and thrift.

In Moon and Raccoon townships, south of the Ohio River, the topography is broken, probably as much as two-thirds of the surface being too steep for profitable tillage. The main roads run along the remnants of the old plateau level, and these remnants are extensive enough to include about one fairly level farm on each side of the road. The farms referred to usually break into sharp ravines at the back, almost every farm including some broken land. The stream slopes and also many of the topographic breaks leading to them are too steep for profitable tillage. Where occupied by a silty loam or heavier soil these slopes could well be used for permanent pasture, as Kentucky bluegrass flourishes on them. Such use is not economically feasible, however, on the steepest parts nor on the light sandy types of soil. Such areas should support small tracts of forest.

The soils on the tillable fields are fine sandy and silty loams which in places are very floury because of the high content of silt. In fact, the fine sandy loam very often contains too much silt for a typical fine sandy loam, yet not quite enough clay or silt for classification as a heavier type. A greater clay content sometimes gives a silty clay loam which often clods where improperly worked. Gardening is an important industry on the sandy soils, but general farming gives little profit. Land is held at about $50 an acre, and where within driving distance of a town is worth that price, but the light soils are not worth it for general farming. Similar prices obtain in Greene and Hanover townships, although 20 to 50 per cent of the land is too steep for profitable cultivation. In Hanover township farms from 8 to 10 miles from a railway station are held at $45 to $50 an acre, this price being influenced by the presence of coal, gas, or limestone. Many farms have been exploited for gas to some extent, and where present free gas for heat and light is included in the above price. In fact, this supply should be made use of where feasible for farm motor power.

In both these townships silty loams prevail, but there are frequent areas of fine sandy loam. The steepest areas are fit only for forestry, but such are numerous rather than extensive. Dairying has been better developed here than in many parts of the county.

In all the townships south of the Ohio River the Ames limestone occurs as lentils in the Conemaugh formation, which includes all this region. These lentils are found on the slopes or tops of the hills, depending on local elevation, and in some cases furnish a cheap source of lime, which is not only necessary in the farm economy, but also expensive when shipped into this region. Attention is called to the

fact that advantage should be taken more freely of the presence of this lime as a source of farm supply.

Crop yields on the Westmoreland soils vary in different districts. In the Ligonier Valley a good farmer gets per acre from 30 to 60 bushels of corn, 30 to 50 bushels of oats, 10 to 20 bushels of wheat, and 1 ton to 1½ tons of hay. These yields are above the average for this district. On 30 acres of plow land 3 horses, 6 cows, and 8 young cattle are kept.

The productivity of the Westmoreland soils is somewhat greater than that of the Dekalb soils. No definite estimate of this difference can be made, but it is possibly 25 per cent, taking the series in large areas, though, of course, this is a relative matter, some Dekalb areas being more productive than other Westmoreland areas.

Yields on the Westmoreland soils are corn, 30 to 70 bushels, averaging 40 bushels per acre; oats, 20 to 40 bushels, averaging 30 bushels; wheat, 10 to 20 bushels, averaging 12 bushels; potatoes usually run from 60 to 200 bushels, but with occasional yields of 300 bushels or more per acre.

The sandy types of the Westmoreland soils are well adapted to growing garden truck, small fruits, early potatoes, etc., for the local markets. They are also suitable for other light farming. The heavier types are well adapted to the growth of general farm crops, to dairying, and to hay for market. The loam and silt loam are excellent for potatoes.

The surface color of the sandy types of Westmoreland soils is brown, yellow, or sometimes gray, a yellowish-brown being the prevailing color. The subsoils are brown, yellow, or reddish-yellow. The reddish color is found where there is the most limestone. These subsoils are not as red as those of the Brooke series, but more red than those of the Dekalb soils. Thin-bedded limestone is found in places and calcareous shales enter into the composition of the soils to a considerable extent. Most of the derivative rocks are fine-grained shales and sandstones. A brief description of the prevailing Westmoreland types follows:

The surface soil of the Westmoreland fine sandy loam consists of brown or yellow fine sandy loam from 8 to 12 inches deep. The subsoil is usually a clay loam, though fine sandy clay is not infrequently found. In places the soil is underlain by heavy stiff sandy loam, which rests upon the typical subsoil at 24 to 30 inches.

The surface soil of Westmoreland loam is a brown silty loam, often a heavy silty loam, from 10 to 15 inches deep. The line between soil and subsoil is usually not abrupt, the soil grading into the clay loam subsoil. The lower subsoil is sometimes as heavy as a silty clay.

The surface soil of the Westmoreland silt loam is a brown silt loam from 10 to 20 inches deep, underlain by a silty clay loam which in

some cases grades into silty clay of lighter color. The surface color includes all shades of brown between light and dark.

The Westmoreland clay loam consists of a silty clay loam to an average depth of 10 inches. The subsoil is also a silty clay loam, but is usually somewhat heavier than the surface soil, and often grades into silty clay in its lower depths.

BROOKE SOILS.

The Brooke soils are associated with the Westmoreland soils, and are found principally in the western half of Fayette and Westmoreland counties and in the northern half of Washington County. From these main areas streamers extend into Allegheny, Armstrong, and Indiana counties on the north, and considerable areas are found in eastern Greene County along the Monongahela River. Isolated areas are also scattered throughout the Westmoreland series, but most of them are too small to be shown on the map.

In topography the Brooke soils include gently rolling, moderately rolling, and steeply rolling areas, the last occurring principally along deep-cut streams.

The Brooke soils are derived from the geological strata named by the United States Geological Survey "The Monongahela Formation." This was included, in the old State Geological Survey, in the Upper Productive Coal Measures. This formation consists of interstratified limestones, calcareous shales, and thin-bedded sandstones. The limestones are generally less than 2 feet thick, but some are as much as 10 feet in thickness, and they range all the way between these dimensions. These limestones are gray or bluish gray and occur at definite elevations above sea level, hence are found at any position on a local hill where this absolute elevation may strike it. Comprehensively stated, however, these soils occur in the broad synclinal valleys which lie within the large area of the Westmoreland soils.

The Brooke soils are derived in part from all the formations mentioned, but limestone always predominates.

Wherever the interstratified shales and sandstones have been of more importance in the derivation of the soils than the limestone the Westmoreland soils have been mapped. Most of the Brooke soils are clayey, the clay loam, silty clay loam, silty clay, and clay being all represented. Of these the clay loam is the principal type. The purest limestone soil is a red clay and is locally called "red limestone land."

Few of the Brooke soils are as light as a loam, though loamy areas are sometimes referred to as being sandy in contrast to the very heavy clays and clay loams with which they occur. The subsoil is aways heavy, ranging from a heavy silty clay loam to a stiff, heavy clay. Where shale or fine-grained sandstone has entered more

largely into the formation of the soils the surface is some shade of yellowish brown. In such areas the soil is more silty, usually a heavy silty loam or a silty clay loam. On some slopes the red limestone soils are exposed in alternation with the brown shale and sandstone soils, one above the other. In such locations the limestone soil is extremely stiff, lumpy, and intractable; in fact, it can only be worked under very restricted moisture conditions. It is thus very bothersome on account of its occurrence in spots which may not be worked at the same time the rest of a field is in favorable condition. Because of this mixture of materials the soil structure of a given field often varies greatly, and not infrequently the texture does also.

Limestone outcrops in places and can be quarried and burned at a low price, thus giving a very cheap source of lime. This is an important agricultural feature, as these soils need lime not only for the correction of acidity to some extent, but also to improve their structural conditions and make them more mellow. In spots the limestone or shale is near enough the surface to injure crops somewhat in dry seasons, but such conditions are found only in small areas. An instance was noted where lime had been applied to part of a field only. Where limed the soil was in excellent mechanical condition, but where unlimed, and with other treatment identical, the soil had baked hard and was very cloddy.

Drainage is an important problem with the Brooke soils. Surface drainage is ample in most cases, but the heavy, close, and stiff character of the subsoil makes artificial drainage desirable. With such soil, however, the expense of installing drains would be heavy, and present economic conditions in the region hardly warrant the undertaking.

Most of the Brooke soils are used for producing general farm crops. Corn yields from 50 to 100 bushels, with an average of 60 bushels (shelled) per acre. Oats, of which there is a tendency to decrease the acreage, yield from 20 to 60 bushels, with an average of 35 bushels per acre. The yield of wheat ranges from 12 to 35 bushels, with an average of 18 bushels per acre. An average yield of hay is 1½ tons per acre, but the yield varies greatly.

The Brooke soils are well adapted to general farming and all kinds of stock keeping. Corn, oats, wheat, and grass all do well, and as the expense of maintaining fertility is much less than on any other upland soils in this part of the State, these crops may be grown with profit wherever good cropping methods are followed. Owing to their heavy character, however, the Brooke soils are much more expensive to work than any other series of soils in western Pennsylvania; hence it may cost as much to produce a bushel of grain on the Brooke soils as on the Westmoreland soils, notwithstanding the fact that the

average yield is perhaps 20 per cent higher on the former. In the production of hay, however, the Brooke soils are supreme. They are especially adapted to dairying and, as the local markets for dairy products are exceptionally good, it is recommended that this business be extended wherever coke smoke does not injure forage crops.

The Brooke soils, as has been said, are hard to work, and as a result many fields were seen in very bad physical condition. Intractable clods literally covered the surface in some cases. It is realized that it is often difficult so to arrange farm work that plowing and subsequent tillage be done under favorable moisture conditions, but too much stress can not be laid upon the necessity therefor. A more general use of lime on the Brooke soils would be found most beneficial. Lining is probably the cheapest means for their amelioration. The soils are so stiff that it is almost impossible to work them satisfactorily unless lime has been used to make them more granular. In addition, clover should be grown for the purpose of loosening the soil and subsoil, as well as for nitrogen gathering from the air. But the clovers thrive on these soils only after liming. Hence applications of lime and the growth of clovers, red or alsike, go hand in hand and are the first requisites for increasing crop yields. After such treatment the tendency of this soil to form clods will be greatly lessened. Upon no other soil in the whole area does lime cause an effect so beneficial as far as structural conditions alone are concerned. Lime and the continued use of clovers would soon so improve these soils structurally that the dread of plowing them and the consequent tendency to leave them in sod as long as possible would in great part disappear. Kentucky bluegrass thrives on the Brooke soils, and local steep areas therein should be left in permanent pastures. From an agricultural viewpoint solely it seems unfortunate that crop production on so much of this excellent soil should be affected by coke smoke. Where the effect of these fumes is at all noticeable, sod is plowed only with the greatest reluctance, because of the difficulty of reseeding successfully even where the influence is slight. Where the influence is more serious it is impossible to reseed with success.

Commercial fertilizers are used to some extent on these soils. The results obtained are variable, as little attention is paid to the needs of the soil, the fertilizer being purchased for the most part by brands without inquiry as to composition.

The Brooke soils are associated with the Pittsburg coal, the most valuable vein in southwest Pennsylvania, hence good markets are always near. Much of it has been included in the price paid for the coal which underlies most of it, and is held in rather large tracts in many cases. Such land is seldom for sale, as its agricultural value is slight as compared with that of the coal; and furthermore the wealthy coal men are in no hurry to sell until the coal has all

been removed from a considerable tract. Farms are frequently sold, however, and where the buildings and improvements range from fair to excellent a representative price for farms ranging in area from 100 acres to 250 acres is $100 an acre. The markets afforded by the coke works and local towns make this productive land yield a good profit at that price. At the time of the survey milk sold at wholesale for 5 cents a quart. In Greene and Washington counties farms of Brooke soils can be bought for less than the above price where the coal towns have not yet developed, and in some cases represent good investments.

VOLUSIA SOILS.

The Volusia soils occur in the northwestern parts of Beaver and Butler counties, and by their location in this survey the determination of the boundaries of the glacial soils of northwest Pennsylvania was completed. Their area in these counties is small, but of particular interest on account of the marked contrast they afford in agricultural conditions, as well as in topographic and regional character, to the shale and sandstone soils.

The most striking superficial characteristic is the planed-off surface of broken topographic features such as immediately supersede this formation on the south. There is thus portrayed very clearly the limit of the southern advance of the glacier in this part of the State. The high points and ridges were not only ground off and left smooth by the tremendous abrasive force of the glacier, but the V-shaped stream courses previously cut in the underlying rock, such as are now to be seen south of the glacial line, were largely filled with glacial débris. Thus the rugged and angular dissection features of the Dekalb and Westmoreland soils are superseded by moderately rolling country of rounded hills and relatively smooth contours.

The boundary line between the Volusia and the residual soils is extremely wavy and irregular. This is undoubtedly due to the different degrees of resistance which the advancing glacier encountered as it neared its southern limit and its great force was weakened to some extent by melting. The border is replete with instances where the glacier could not advance over a relatively high sandstone and shale hill, but split and passed around it on both sides, leaving a glacial soil mantle on the lower slopes which belongs to the Volusia soils, while the hill tops are of the Dekalb or Westmoreland series. The glacier simply followed the lines of least resistance as it melted away, leaving definite Volusia soils at the lower elevations. Under such conditions soils are complex in occurrence as compared with any of the soil series derived from residual materials. To illustrate, on a particular farm in Butler County narrow bars of Volusia gravelly fine sandy loam occur next the highway, but as the farm spreads out beyond mixed areas of fine sandy loam, silty loam, silty clay loam, and

some clay loam appear. All these different characters of surface materials are usually underlain by gravel at depths ranging from 24 to 30 inches. This affords good drainage. Heavy clay overlies the gravel in some places, however, and this necessitates artificial drainage to obtain good results. Farther north of the morainic line the soils are more uniform, the Volusia loam being the prevailing type, with small areas of silty loam and clay loam. These soils are easily worked and productive. Very good farms in this district range in price from $40 to $60 an acre.

In northwest Beaver County the Volusia boundary elbows in and out all the way from Lawrence County to the Ohio line. While following in a general way the geological glacial line of Leslie[a] it is usually far removed from it. Not only is the boundary line sinuous or wavy, but in many places it is dovetailed, the glacial débris along the boundary having been eroded away on the lower steep slopes, leaving the underlying shales of the Dekalb or Westmoreland soils exposed. It should be here noted that along this boundary there are many local areas of the Dekalb soils within the area mapped as Westmoreland. The smooth surfaces of the hilltops and elevations of all sorts still have the superficial glacial covering which throws the soils in the Volusia series. This covering is often shallow and where too thin to determine the character of the surface soil to plow depth it has been left in the Westmoreland series as far as practicable on a reconnoissance map. The drift is usually deep enough to be included in the Volusia soils and ranges from that to a depth of 2 or 3 feet or more. Glaciated bowlders of granite and allied rocks, some of them from 2 to 4 feet in diameter, are well rounded. Some of these can be definitely traced, i. e., a fossiliferous limestone and well-rounded Medina sandstones from New York.

The glacial soils along this dovetailed boundary are somewhat less productive than the deeper glacial soils no more than a mile farther north, but there is no sufficient reason for separating them therefrom.

The Warren soils, mapped for the first time in the adjoining area covered by the Reconnoissance Survey of Northwestern Pennsylvania in 1908, were not of sufficient area for recognition in the 1909 area. In a few instances conditions indicated that the Warren series would soon develop, but areas large enough to be mapped never materialized. The underlying shales, which correspond to the basal material of the Warren soils, never have the blue color of the shales giving rise to that series, but have instead the yellow or brown colors of the Westmoreland and Dekalb soils. Stray glacial bowlders sometimes occur across the Volusia soil boundary on soils which are unqualifiedly Dekalb.

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[a] Report on Terminal Moraine.

The Volusia soils are principally loams. These are often silty, but there is very little silt loam. Where of good depth, as they usually are, the Volusia soils of this region are well farmed. Land prices here do not differ materially from Volusia prices in Butler County.

The general farm crops are grown. Corn yields from 40 to 60 bushels (shelled), oats 25 to 45 bushels, wheat 12 to 25 bushels, and hay 1 to 3 tons per acre. For hay production these soils are especially desirable.

The Volusia soils are well adapted to general farming and dairying. Cultural methods are fairly adequate as compared with other regions, and there is not enough of the Volusia silt loam present to lead to the difficulties experienced with that type as it occurs farther north, and as described in the 1908 report.

Lime is used to some extent on these soils, but its use should be made more general so that success with clover would be more common. Too many farmers fail to grow enough of this crop. No farmer can afford to get along without a large acreage of clover, which will not only improve the soil, but provide a cheap supply of home-grown protein to feed to the dairy herd which these soils are so well adapted to support.

Colluvial Soils.

Jefferson soils.

In traveling over extensive areas of the Dekalb and Westmoreland soils one can hardly fail to be impressed with a certain type of soil erosion and soil translocation on account of which the Jefferson soils have been separated from the main upland series of the Allegheny Plateau.

The original plateau level was composed of shales and sandstones representing a wide range of hardness and resistance. Under such conditions surface waters at some conceivable "first time," after the present orographic and geologic conditions were established, followed the lines of natural gravitation. Meeting in their course lines of less resistance on the slightly soluble clayey shales than over the hard and more insoluble sandstones and sandy shales, their course was soon shaped to follow these lines. As the distance from the source of these streamlets increased, and as time wore on, main drainage channels were established along the lines of least resistance over the more clayey shales, while the sandy shales and sandstones were left to form the ridges and varied uplands of the local watersheds between the main channels.

Depending largely upon the relative extent of these two classes of materials to each other, saucer-shaped areas began to form where the more soluble clayey shales were found. Depressions of this sort are of all sizes, some of the largest covering as much as a thousand

acres. They are worn down evenly and the local drainage is not deep cut, but eventually and characteristically the waters flow through a rimlike circumference which has been cut down deeply enough to afford ample main line drainage channels, though these must be supplemented in part by artificial drains before crop yields commensurate with the excellent possibilities of these soils will be secured. Areas of this sort are to be seen in all stages of progress, but they are almost uniformly of saucer shape.

The Jefferson soils occupy another topographic position much farther down the stream, where the present channels are cut more or less deeply, but have left indications of a halting or terracelike stage a good many feet above the present water course. These benchlike formations are not true terraces, however, for they are not characteristically level, but sloping. The present surface soils of these areas have been formed from the wash, creep, and drift from the Dekalb and Westmoreland soils. Hence they are chiefly colluvial in derivation, but in some cases at least the basal material must have been a former valley floor below which the stream has cut its present channel. These valleys are generally U-shaped, and in them these soils occupy the same relative position that a second bench would in a distinctly terraced valley. The soils are usually deep, but always rest upon basal shales, and while local in derivation the soils are no longer in situ. This soil does not differ in manner of formation from similar positions in the Dekalb areas of the Appalachian Mountains, but in the latter they are of much less extent, and owing to the deeper dissection of the region and more erratic methods of soil formation they have seldom assumed so definite group characteristics, and as a rule have been included in the Dekalb areas.

In both the colluvial-terrace areas and the saucer-shaped areas of the uplands, then, the Jefferson soils have been formed from clayey shales, with attrition from surrounding rimlike uplands. The soils are almost always as heavy as a silt loam or a silty clay loam. The silt content is universally high. Silty clay loam, silty clay, and silt loam form the subsoils. The Jefferson soils are too well drained and too productive for classification with the Lickdale soils. In the early part of the season these soils were not separated, as they were not deemed large enough on the scale of map used, but as the season advanced and larger areas were encountered the necessity for so doing became apparent. A detailed soil survey would show many important areas of these soils.

Good yields of the general farm crops are obtained from the Jefferson soils, but they are not as well adapted to the cereal grains as to the growth of corn, grass, and forage crops.

These soils are not more difficult to work than the silty upland soils, but the same precaution, viz, not to work them when so wet or so dry as to form clods, should be observed. Definite land valuation can not be given for these soils, as they rarely include a whole farm and so are governed by the price of associated uplands.

Terrace and Bottom-Land Soils.

The terrace soils of this area include a very wide range of soil materials under variable conditions of formation. They also give the key to the separation of the glacial outwash soil materials from those occupying terraces to the southward, which are derived from sedimentary rocks. Each of these groups of soil has both first and second terraces. In the glaciated area of Volusia soils the first bottom lands are classified as the Genesee series. The second terrace soils of this series are wanting in this area, but in the area adjoining on the north where mapped in the Reconnoissance Survey of 1908 as Wheeling soils they are of much importance.

The Wheeling soils previously mapped in the Volusia region are now reclassified as the new Chenango series to show their relation to similar terraces in southern New York, where they occur in larger areas. Their name has been selected from important areas in New York along the Chenango River. This change in name has been made because it is now recognized that the terrace soils in the glaciated region have sufficient material differences from the terrace soils in the residual region to the south to warrant their separation.

In the region of sedimentary soils the first bottoms or terraces belong to the Huntington series of soils and the second terraces to the Wheeling series. These terraces have been derived primarily from the shales and sandstones of the Allegheny Plateau and Appalachian Mountains.

Small areas of a high preglacial terrace form the Kittanning soils. Meadow includes a multitude of poorly drained soils adjacent to stream courses. The Meadow soils are so miscellaneous in character that they have been mapped in all series simply as a soil condition regardless of their derivation or the series with which associated.

Genesee Soils.

The Genesee soils are limited in area, as they include only the soils grouped as the first terrace lands of the Volusia series. In low places these soils are subject to frequent overflow, but the higher portions, as at Darlington, are rarely overflowed, such events being restricted to early spring freshets. The color of these soils is variable. Dark brown is most common, but blackish gray is frequently seen. The subsoils are yellowish brown or gray, but where drainage is poorest some mottling occurs. These soils have been derived from

the reworked materials of the shale and sandstone uplands, much mixed with washings from the glacial drift. The textures of the Genesee soils of this area are variable but types heavier than sandy loam predominate, a silty clay loam being perhaps the most common. The highest parts of the Genesee soils are used for general farm crops, corn and grass prevailing, though potatoes and garden crops are also grown with success. Low-lying areas are kept in grass for mowing or pasturing.

HUNTINGTON SOILS.

The Huntington soils occur as first bottom lands in the Dekalb-Westmoreland-Brooke soil region. In places where not too subject to overflow corn is grown to some extent, but most of the cleared areas are kept in meadow or pasture. Where overflow is more serious and especially where washing would be injurious local areas are not cleared. Where such conditions prevail Meadow would be separated on a more detailed map, but it was not practicable to do this on the reconnoissance scale.

The Huntington soils furnish excellent pasturage in many places, and are prized for this purpose. Their texture is extremely variable, but is usually fine enough to retain a good moisture supply.

WHEELING SOILS.

The Wheeling or second terrace soils are well developed along the Youghiogheny, Monongahela, Kiskiminitas, lower Allegheny, and Ohio rivers, and to some extent also along some of the large creeks, especially the Connoquenessing.

Topographically striking in appearance because of their location on benches in a region of upland otherwise strongly marked by rolling features, the Wheeling soils are complex and variable in texture. The soil materials, while probably deposited during glacial flooding of the streams, are largely of local origin. Several theories have been advanced to explain the method of their formation. Some of these are mentioned and described in the Masontown-Uniontown Folio, No. 82, of the United States Geological Survey. These will not be discussed here. The soil-forming materials were laid down in water, varying greatly in depth and velocity, and some of the soil débris was undoubtedly brought from glacial outwash. As a result of so much commingling of materials their range in texture is not only wide but the change between types is often both rapid and abrupt.

In the course of the formation of these terraces streams must have become dammed so that new channels were cut. The abandoned channels have been designated in Folio 82, United States Geological Sur-

vey, as the Carmichael formation of Pleistocene age. These soils are included with other second-terrace soils in the region. In the area just north of Masontown, Fayette County, sandy loams of medium texture prevail, though spots are coarse sandy loam. The subsoil is usually a medium to coarse sandy loam, but sometimes is of heavier texture. On the north side of the area, where it adjoins the limestone uplands, the soil is blackish clay loam or clay. In the Connellsville district coarse loams predominate. Round stones, from fist to cantaloupe size, almost always appear in sectional cuts. In Pittsburg "The Point," about as far up as Smithfield street, belongs in the Huntington or first-terrace soils, and similar low-lying areas wherever they occur have been included in this series. In some places two or even three narrow benches are well defined, and there the prevailing condition has been mapped.

At Monaca, opposite the confluence of the Beaver with the Ohio River, a high terrace has been included with the second terrace. The soil consists of stiff silty and fine sandy loam. So stiff is this soil that cuts remain perpendicular in some cases. In these soils gravel, which is a characteristic of the second terraces, is almost wanting. At Bellowsville the terrace is a fine sandy loam with a stony subsoil. The stones are from 1 to 5 inches in diameter and well rounded. Near Zelienople, in Butler County, the Connoquenessing terraces include many productive farms. In fact, the Wheeling soils as a whole would be good farming soils were it not for the fact that it has been necessary to use them for town sites, as they are not infrequently the only available locations. On Muddy Creek the Wheeling soils are not typically developed, as they are much mixed with the Huntington soils.

In Greene and Washington counties the surface soil is usually a silt loam or silty clay of a brown or dark-brown color. The subsoil ranges from a loam to a clay, brown or gray in color. In general, these soils are fairly well drained, but level or slightly depressed areas need artificial drainage.

Near cities and towns the Wheeling soils, where cultivated, are used largely for market gardening, but where more distant from markets general farm crops are grown. Yields are good where cropping systems are efficient, but vary greatly, and in some cases are low on account of indifferent treatment.

KITTANNING SOILS.

The Kittanning soils are of small area, but were separated from the other terrace soils because of their unusual elevation above the streams near which they lie, as well as for the character of the materials from which they have been formed.

Professor Butts, in Folio 115, United States Geological Survey, states that these high terraces, 250 feet above the river, are the remnants of a former broad valley floor bounded by the high, steep walls of the uplands. These soils contain gravel and pebbles of Medina sandstone and crystalline rock, and hence are early glacial outwash materials, probably of Kansan age. Areas of these soils are distributed along the Allegheny River and other streams for a long distance back of the terminal moraine. In many cases these do not occupy sufficient area for recognition on the reconnoissance scale, but in other cases they undoubtedly do, even where not shown, as it did not seem feasible to spend the time necessary for determining such location.

The soils are largely gravelly sandy loams, though clays and silts are also found, frequently as lenses.

Owing to their position and character, these soils are not extensively cropped, but are used to a slight extent for garden crops and rarely for general farming.

CLIMATE.

Regional contrasts in climate do not occur here as in the area covered by the Reconnoissance Survey of Northwestern Pennsylvania, but local contrasts are marked. In the northern part of the present area the winter is rigorous, winter temperatures are lowest there, and the cold is made more severe by strong winds. In fact, cold winds are the only disagreeable climatic feature of the region. Westerly winds sweep to the crest of Allegheny Mountains, and all the plateau remnants, hilltops, and ridge tops are within its course. The greatly diversified surface leaves much of the whole region protected from such winds, however, and there the climate is moderate and pleasant. In the northern part of the area the snowfall is sufficient for considerable good sleighing, but in the southern part there is very little.

The occurrence of angular valleys, as previously described, directs the course of cold-air drainage through them, and crops in such positions are often injured by frosts. The average dates of occurrence of killing frosts in spring and fall at a number of different places follow: Aleppo, May 11 and October 4; Butler, May 3 and October 4; California, May 2 and October 11; Derry Station, May 6 and October 4; Hawthorn, May 4 and October 4; Irwin, May 4 and October 6; Indiana, May 7 and October 8; Lycippus, April 30 and October 17; and Uniontown, April 26 and October 23, respectively.

The rainfall is usually ample and well distributed for successful crop growth.

Below are given weather records to illustrate the conditions at different points in the area surveyed:

Normal monthly and annual temperature and precipitation.

Month.	Franklin.		Indiana.		Pittsburg.		Derry Station.	
	Temperature.	Precipitation.	Temperature.	Precipitation.	Temperature.	Precipitation.	Temperature.	Precipitation.
	°F.	*Inches.*	°F.	*Inches.*	°F.	*Inches.*	°F.	*Inches.*
January	26.2	3.70	28.8	3.46	30.7	2.87	29.6	3.68
February	23.4	3.28	28.1	2.72	31.8	2.66	26.4	3.08
March	38.2	3.45	39.1	4.47	39.5	3.01	41.2	5.00
April	46.1	2.62	49.6	4.04	51.0	2.90	48.3	3.76
May	58.4	3.35	60.0	4.60	62.6	3.30	61.7	3.57
June	66.0	4.82	66.9	4.88	71.1	3.89	69.1	5.19
July	71.4	4.75	70.5	4.74	74.6	4.42	73.9	5.26
August	68.7	3.65	69.2	4.37	72.5	3.18	71.1	3.96
September	64.0	3.69	63.8	3.63	66.1	2.48	66.5	2.23
October	52.4	2.88	51.0	3.10	54.9	2.36	54.9	2.81
November	39.7	3.23	40.9	3.02	42.9	2.55	41.6	2.87
December	29.1	3.34	30.7	3.52	34.7	2.73	34.4	3.39
Year	48.6	42.76	49.9	46.55	52.7	36.35	51.6	44.80

Normal monthly and annual temperature and precipitation.

Month.	Irwin.		Lycippus.		Uniontown.		Aleppo.	
	Temperature.	Precipitation.	Temperature.	Precipitation.	Temperature.	Precipitation.	Temperature.	Precipitation.
	°F.	*Inches.*	°F.	*Inches.*	°F.	*Inches.*	°F.	*Inches.*
January	30.7	2.19	29.1	3.51	32.2	3.57	29.8	3.16
February	28.0	2.21	26.6	2.88	31.1	3.19	27.0	2.34
March	43.2	4.67	40.0	4.12	40.9	4.09	43.5	4.91
April	50.2	3.52	49.1	3.59	50.6	3.68	48.6	3.86
May	62.4	3.18	61.1	3.96	61.7	4.39	61.2	3.75
June	68.2	4.96	68.5	4.24	70.3	4.75	67.2	3.98
July	73.0	4.73	72.7	5.14	73.1	5.67	72.3	5.16
August	71.4	3.94	71.0	4.03	71.6	4.38	70.2	3.38
September	67.2	2.37	66.8	2.64	66.0	3.09	65.3	2.54
October	55.4	2.43	54.5	2.44	54.0	3.00	53.3	2.52
November	43.0	2.33	42.0	2.54	43.2	3.35	40.7	2.00
December	33.0	3.20	32.3	3.56	35.0	3.76	31.7	3.49
Year	52.1	39.73	51.1	42.65	52.5	46.92	50.9	41.09

REVIEW OF THE DEVELOPMENT OF AGRICULTURE IN THE AREA.

The early settlement of southwestern Pennsylvania was beset with many difficulties. Even when enthused with a spirit for exploration, the Allegheny Mountain district looked forbidding to the early colonial settler of the Atlantic seaboard, and checked for a time his will to see what lay beyond. A healthy curiosity, however, was soon

augmented by stern military necessity to learn of the character of the association of French traders and explorers with the Indians who inhabited this region. There was rumor that the French intended to get possession of this territory, and it was becoming apparent to the English colonists that the mountainous area was not a safe bulwark against possible enemies beyond. It was also necessary to learn more of the river by which the French from Canada had such direct access to this territory. So surveyors, of whom Col. George Washington was one, were sent during the course of several years to get more definite information of the conditions.

The broken topographic character of the country and the dense forest cover in many places made travel exceedingly difficult under prevailing circumstances, and as a result the main lines of travel that developed followed the trails made by buffalo when in quest of fresh salt licks, change of climate, and forage.

Such a trail ran from the Potomac River at Cumberland, Md., to the junction of the Allegheny River with the Ohio. This was the general course of Washington's road and of Braddock's road; and when Congress appropriated money for the construction of a government highway between these two points, it too followed in a general way this old trail, though frequently crossing and recrossing it.[a] This old national highway was conceived by Albert Gallatin, and commissioners were appointed by President Jefferson in 1806 to report on the project. In 1811 the first contract was let for 10 miles west of Cumberland, Md., which was its eastern terminus. This highway ran directly through the area of the present survey. By 1817 contracts brought the road to Uniontown, Fayette County. In 1818 mail coaches were running over it in their course from Washington, D. C., to Wheeling, W. Va. The traffic which followed the opening of this road was enormous, a single one of the five commission houses at Wheeling paying $90,000 for the freightage of goods over the road in 1822, and unloading 1,081 wagons which had an average load of 3,500 pounds each. This heavy traffic wore out the road so rapidly that many experiments with macadam materials were tried with more or less success, but the road remained very rough.

To accommodate this heavy traffic wayside inns and stables for transfers of stage horses were established only short distances apart, and around them little trading posts and settlements sprang up, some of which soon became prosperous villages and towns.

Over this road there was a steady stream of immigrants west, and as locations along the route chanced to strike the fancy of a family,

[a] Much of the information concerning the establishment of this historic highway has been gathered by the writer from Hulbert's book, "The Old National Road."

or as necessary halts were made on account of sickness, breakage of wagons, injury to teams, etc., on account of the extreme roughness of the pike, those who tarried soon formed settlements. In this way areas along the old national highway were rapidly settled. An idea of the scope of the traffic may be gained from the fact that "the population of the three States west of the Ohio through which the national road ran increased from 783,635 to 3,620,314 in the generation the road was in active use." This, of course, was before the advent of railways. The average increase of permanent population for the first five decades in these States was over 182 per cent per decade. In the second decade of the century Indiana's population increased over 500 per cent. This record has been equaled only three times in this country. In all this rapid exploration, settlement, and development the old national road had a preponderating influence.

The business contingent on the traffic of this highway of national importance and on the rapidly increasing population along it created a strong demand for farm products. In a short time, too, this road carried more freight than any other in the whole country at that time, and was comparable only to leading trunk railways of to-day. Soil products were in great demand. It took large amounts of hay and grain to supply the horses of the passenger and freight vehicles, together with the teams of the streams of immigrants; and food supplies were in similar demand. There was a good market for beef cattle, hogs, sheep, dairy products, potatoes, and the common vegetables, and so there was much incentive to improve farm lands.

With increasing distance from the national road the lateral highways became more difficult, and agricultural methods were so shaped that the individual farm became more of a self-sustaining unit. From such locations beef cattle and sheep were the principal sources of income, as they could readily be driven to market. An important factor in the successful production of cattle and sheep was the excellence of the pasture grasses. Kentucky bluegrass grew luxuriantly, especially on the newly cleared Brooke soils and the more limy areas of the Westmoreland soils. As a result farming was in a flourishing condition. Farmers made money, and, naturally under such circumstances, increased their holdings. Even at this early day soil adaptation to different crops soon asserted itself, good soils bringing wealth to their owners, while from others only a poor living could be obtained. Old cellar holes of former dwellings and other marks of residence and farm operations are still traceable on the relatively small areas of poor soils.

After the advent of railways general farming prevailed. The good lands were in large holdings, often including several hundred acres, and occasionally from 1,000 to 1,500 acres. Farm management was on the old-fashioned extensive basis. Farmers prospered

even by farming as much of their land as possible and leaving the rest idle.

Good yields of staple crops, corn, oats, wheat, and grass, made this a stock-keeping country of note, especially on the Brooke and the best of the Westmoreland soils.

Nor was there any marked change in the steady development of this healthy farming condition of the first half of the last century until activity in coal mining began. The fact must not be lost sight of, however, that even in the earliest and best-developed sections there was much rough and steep land which was left in forest. In clearing the areas first farmed much waste of timber had taken place, but for a long time the steep hills and gorges continued to furnish large supplies of forest products for the rapidly developing region, and also for shipment as transportation agencies increased.

In the northern part of the area, where the elevation of the prevailing Dekalb soils is higher than in the region just described, agricultural development was much slower. Lacking the business development and transportation facilities afforded by the national highway to the region farther south, and even less accessible because of the deeper and steeper V-shaped valleys, the removal of the heavy forest cover was very slow. As described in the chapter on Dekalb soils, high level or gently sloping remnants of the old plateau level are separated in this region by deep and sharp gorges. These level areas were commonly chosen for settlement while the virgin forests were being cut. Tanbark, especially from the hemlock, was an important product, and with lumber constituted the chief sources of income. The only farming in these early days was the production of supplies for local consumption. The discovery of petroleum oil caused very rapid temporary development in spots, and has brought wealth to successful exploiters. The oil business is still lucrative. The forests have been largely depleted, and the removal of what is left of this great resource is now accelerated by competing lumber dealers, who realize that there will not much longer be room in this business for many of their number.

PRESENT AGRICULTURAL PRACTICES.

As already seen, the present agricultural practice of the area is not a normal development of the soil resources which the early settlers found, nor, indeed, of the healthy and vigorous farming conditions that continued until after the middle of the last century. The discovery and exploitation of vast areas of coal worked an economic evolution so rapid that all other interests were grouped about this new source of wealth and its development.

It is a striking coincidence that the old national highway should run over the Pittsburg vein of coal, the richest in the region, and that

the thick beds of the purest limestone always associated with that coal should here give rise to the most productive upland soil in western Pennsylvania. Hence farming, although first developed along this highway by the force of circumstances, sought no removal as surrounding areas were developed. These limestone lands, including the Brooke and best located Westmoreland soils, were eagerly taken up, and a prosperous agriculture, of which the rest of the country has heard little in recent years, then flourished. Corn, oats, wheat, and grass were the crops. In 1860 to 1870 the average yield of wheat was 20 bushels per acre, though 35 bushels were sometimes obtained. Every good farmer then limed his land and good crops of clover were easily secured.

With the development of the coke industry, which first assumed importance in the decade between 1870 and 1880, the large landholders naturally became much interested and often obtained fortunes. Their attention was diverted from farming thereby, and at this point comes the transition to the poorer agriculture which has since obtained. Tenants decreased the use of lime, and trouble with clover began. More hay and grain were sold instead of being fed to steers, and farm productivity decreased. When an important percentage of the strong men who had prospered in farming diverted their energies to the production of coke because of the greater profits to be obtained in that business, the agriculture of the region suffered. Outsiders flocked to the coal fields, but none went to the farms of the caliber of those who had left them. Furthermore, the farms were rarely sold by the well-to-do, the men who developed the new industry. These men held the lands, but did not have time to continue effective farming operations upon them. Regrets for this decline in agriculture are futile. Men are going to do that which brings the most profit. The only regret is that farms have often been allowed to run down by those who have followed the leaders, and are now not nearly as well off as they would be had they remained on the farm. And this tragedy is still going on. It is also unfortunate that good farm lands should be held by those who have no interest in their development, for it gives an appearance of agricultural stagnation on soils that deserve better treatment.

There are two legitimate causes for the abandonment of good farm lands, or lands that have been good, in this region. In the immediate vicinity of coke ovens the smoke kills all vegetation and leaves consequently a gruesome landscape. The winds carry this smoke even farther and injure in varying degree crops and trees. The removal, secondly, of coal veins which lie relatively near the surface often causes the surface soils to cave in, and even where this does not occur the soil water disappears so rapidly through the mine galleries that it is impracticable to try to grow crops.

The injury by water removal depends largely, of course, upon the distance of the galleries below the surface, but the tilt of the underlying rock and the character of the lower subsoil also have some effect. Where the galleries are from 50 to 100 feet below the surface little if any damage is done, and a lesser distance may not bring serious results.

In a much wider zone around the coke ovens the injury of smoke to vegetation, while less conspicuous, is serious. Soot from the furnaces is wafted long distances when the wind is right, and eventually collects on all growing things. Steers formerly fattened nearly as well here as in the famous bluegrass region of Kentucky, and prime fat cattle were the leading product. Now a wisp of grass drawn through the hands will leave them sooty. Of this, cattle will eat enough for sustenance, but they do not fatten satisfactorily. Hay is affected, of course, in similar manner, and where the injury is severe bare spots in the sod appear. Under such conditions it is very difficult or impossible to reseed the ground. In a half-way stage of injury grass grows in bunches. Under such conditions there is no profit in cropping. Corn does fairly well, but the stover is of little value.

This coke-smoke injury is the most serious drawback to farming in southwest Pennsylvania. A form of furnace has now been devised which consumes its own smoke. If this form could be universally adopted it would be of great importance to the agriculture of the whole soft-coal region. This could only be done gradually without working some economic injustice, but there seems to be no appreciable unity on the part of farmers to demand that this type of furnace be installed. When coal is sold in Pennsylvania practically unlimited rights of extraction go with the title.

A third economic reason why farming tends to decline on good Brooke and Westmoreland soils is that farmers find it difficult to pay farm help as high wages as they can make in the mines or at the furnaces. During the summer the survey was made men were paid 90 cents an oven for tending furnace, and that was just after labor had been resumed following an extended shutdown. Any able-bodied steady man can haul two ovens a day, netting him $1.80, while the industrious frequently haul an extra oven, in this way earning $2.70 a day. The work is hard, but not unhealthful.

A fourth economic reason for lax soil management is that many a farm owner finds that he can make more money at work with his team—the wage rate in 1909 was $4.50 per day for driver and team—than he can by the system of general farm management that he has been pursuing. So he keeps his farm largely in grass, harvests his hay as quickly as possible, and works out the rest of the time. Not infrequently such a man keeps one or two extra teams and hires

drivers for them if he has no sons. This plan brings a very good income, as enough hay for the teams is grown on the farm even if the acre yield is low, and at least enough cows and pigs are kept for home supplies. This course will continue to be followed by many farmers who live near enough mine openings to make it practicable. Many farmers who have small veins of coal on their farms grow crops in the summer and dig coal in the winter. With good management this makes a very effective combination.

Statistics of land tenure are not given because of the variability of conditions. The management of a great deal of land depends upon local coal interests and other unusual conditions, so that data on tenure and rentals would not be comparable with that of other regions.

One of the important problems of soil management is the control of soil erosion, and this applies to most of the whole region surveyed. Washing and gullying is very destructive. In Greene and southern Washington counties steep slopes are often protected by following the contours of the hill in plowing and in all other tillage processes. Strips of sod, or "lands," several feet wide, likewise following the contours, are left unplowed to catch and hold the down-hill wash from the tilled plats above. This is particularly essential on the Meigs soils. These sod strips are not plowed until the corresponding year in the second course of the rotation.

The average farmer pays little attention to erosion, for the primary reason, apparently, that he does not realize its seriousness. A very severe shower of June 27 washed large amounts of surface soil from the cornfields in Armstrong County. Loads upon loads of the fine and fertile sediments were lodged against the fences on the lower sides of the fields and deposited in the roadside ditches. These visible after effects represented only a part of the washings, for small amounts were unnoticeable and large amounts were carried off to the larger streams and thus disappeared. So serious was this loss that the value of the fields was decreased by not less than one-third. Yet, in talking with the owners of such fields in the next few days, in many cases standing on the fields and talking about the soils, this loss from erosion was rarely alluded to unless in reply to a question, and even such replies showed that the extent of the injury was seldom realized.

Over the vast region of the Allegheny-Cumberland Plateau sloping from the crest of the Appalachian Mountains westward to the Great Lakes and the Ohio and Mississippi rivers, and extending from New York to Alabama, the soils are now being steadily and all too rapidly eroded, to the great impairment of their productivity. In the majority of cases the erosion consists of an almost insensible creep. This results in a constant attrition of silty material if erosion is con-

trolled, but hard, unproductive soils and gullying if erosion is not controlled.

So prone have been farmers in the Northeastern States to think of destructive soil erosion only as an evil with which the southern farmer has to contend, where its effects are so glaring, that he has left unnoticed in great degree the slower, more subtle, yet steady loss which his own soils have been undergoing.

In Pennsylvania there are tremendous areas in the aggregate of silt loams and silty clay loams located on hillsides and fields of sufficient slope to be materially affected by erosion that suffer seriously from this cause. This is especially true in the Westmoreland, Chester, and Upshur series and to a considerable extent with the Brooke and Dekalb soils. On such areas an essential in soil management is the control of this tendency. Contour plowing, a gradual deepening of the tilled surface, liming, and a marked increase of the humus content, whereby the soil becomes more spongy to as great a depth as is practicable, and thus can absorb much more of the rainfall instead of letting it run off, and a winter cover crop for all sloping fields at least, are the principal means for preventing erosion. But such treatment pays directly in money return not only in lessening erosion, but also by getting the land into a much better condition for growing crops. Hence this method of preventing erosion is the same, as far as it goes, as that described for increasing crop production. On steep fields corn ground should have a winter cover crop, although this is now seldom done. Cowhorn turnips or rye will serve for this purpose, and the vetches should be given careful trial, as they have the additional advantage of being legumes.

SUGGESTIONS FOR SOIL IMPROVEMENT.

When an important percentage of the farms within a given area are rented to tenants because the owner is too busily engaged in other occupations to attend the farm himself, or even to take care that the tenant management be such as to maintain the productivity of the soil, it is unfortunate for the agriculture of that section.

When the tenant, on the other hand, can secure a farm for only one year's lease with possible privilege of renewal he can not be expected to have material interest for increasing the productivity of the farm for the benefit either of the tenant who may succeed him or for the owner. Yet such is often the condition in southwest Pennsylvania, because the coal right on the farm may have been sold, or the owner may be awaiting only a satisfactory offer for it. When sold it is optional with the coal operator as to when he shall begin work. If the tenant's crops chance to be half grown, their trampling or injury from other source is his loss. He has no redress. For the landowner

it is a plan to get what return he can so long as a tenant is willing to take the farm. Of course there are many exceptions. There are many good tenants who maintain the productivity of farms, get ahead financially, and make the investment a paying one for the owner. They prove that the only possible profit for either tenant or owner is made by a system of management that shall maintain or increase the productivity of the soil. In other words, the only profitable system for either landlord or tenant is one having as a basis permanent soil improvement and increased crop yields thereby. This must be based on more than one year's tenure, and then may be profitable to both tenant and landlord alike.

Farms are usually rented on a share basis, though not infrequently for a cash sum. If the farm owner furnishes stock and tools for running the place he gets one-half the crops or products; if the tenant furnishes the stock and tools he receives two-thirds the crops or products.

Many farms are run by owners who are waiting to sell their property. Of the owners many are conscious that the underlying coal will eventually cause a sale, and so they will make no improvement, and let the farms run down. For this class there is no excuse. In fact many of them persist in standing in their own light, though there are, to be sure, exceptions. In a few cases an early sale is almost assured. But vast numbers get no reasonable return from the agricultural use of good land.

Fortunately there is a fourth class of legitimate farmers who manage their soil and arrange cropping systems the best they know how, and in many cases they well know how. These are the men to whom farming is best worth while.

With a range of conditions so broad only those suggestions for soil improvement that are generally applicable can be made.

Most of the soils of the area are deficient in humus and need regular applications of lime. For a study of the uses of lime the reader is referred to special bulletins on that subject. To state some of the reasons for its use briefly, however, most soils under continuous cropping tend to become acid. Adequate crop yields are seldom, if ever, obtained when the soil is in an acid condition. One of the reasons is that nitrifying bacteria flourish only in soils that are nonacid or alkaline. Lime is the cheapest neutralizer of acid conditions in the soil. Because of its flocculating effect lime makes clayey and silty soils more mellow, so that they do not clod as readily if worked when moisture conditions are not just right. Contrariwise, lime makes sandy soils more loamy and retentive of moisture by filling, in part, the larger spaces between the grains of sand by flocculation of the fine grains of clay. Lime also makes the phosphoric acid and potash in the soil more available for the use of crops.

In other words, the crop can not make full use of the phosphorus and potash already there unless the soil is alkaline. Those plants that can gather free nitrogen from the air and thus increase the productivity of the soil, such as clover, require larger amounts of lime than most other crops. They constitute the cheapest known source of nitrogen for the use of plants. Clovers constitute also one of the cheapest sources of humus, the material that in addition to lime keeps soils in a mellow condition favorable for crop growth. Stable manure adds humus to the soil. So does any green crop or plant plowed under, and so do all plant roots. Clovers and other legumes have extensive root systems and hence add relatively large amounts of humus to the soil, even when the crop itself is harvested.

If advantage is not to be taken in this region of using these two primary agents for making soil more productive, there is little opportunity for profitable farming. On the other hand, by an adequate use of these agencies many of the soils would yield very profitable returns, though at present not doing so. These two lines of soil treatment are fundamental and represent the basis upon which further treatment should rest.

Seldom is any extensive area outside of a limestone valley so fortunate as this one in having cheap sources of lime. Many farmers quarry limestone on their own farms and dig coal from a vein alongside with which to burn the lime. The work is done at dull times and the cost is thus extremely low, some farmers, by counting labor at regular prices, getting burned lime for $1.50 to $2 a ton. Others buy coal somewhere in the neighborhood at a rate of 3 to 5 cents a bushel to burn their own limestone. Others buy both coal and limestone, doing the work themselves, and so get burned lime for an average price of $3 or less per ton. Not infrequently local owners or companies make a business of burning lime and selling it near by at about $3 a ton. Where lime is not found for local burning the price ranges from $4 to $6.50 a ton. There are few localities, however, where limestone is so far away that good business acumen on the part of the farmer will not enable him to get lime for much less than $6.50 a ton. It seems absurd that farmers should in some cases pay this price for lime shipped from the central part of the State when it can be had from the kiln within a distance of 10 miles. The roads are usually hilly, making the haul difficult; but farm teams are standing in the barn when they might better be employed hauling lime even under these road conditions.

Notwithstanding the facilities for obtaining lime, in many localities not more than 10 per cent of the land is limed. Hence stress is here laid on the necessity for its use.

Lime is not a fertilizer, however, and unfortunately some farmers have not understood this. Lime has frequently been used as a fer-

tilizer, and an increased crop yield has made it seem like a fertilizer. In such cases the increase was due to lime effects already described and not to any increased fertility. If the use of lime as a fertilizer is persisted in, without using stable manure or commercial fertilizer in connection with it land will soon become less productive.

Stable manure contains large amounts of humus, and were the supply unlimited the humus problem would be simple. In this region a combination of stable manure and leguminous crops is the most practicable way to acquire the necessary supply of decayed organic matter for the soils. Of the leguminous crops the red and alsike clovers are of the most general use for this region. Alfalfa is still more beneficial for the exceptional man who will take the precautions necessary for success with this crop under eastern conditions. No one should try it, however, who fails to grow the clovers successfully. If it is hard to grow clover, it is harder to grow alfalfa. Some farmers have succeeded with it, getting 3 to 3½ tons annually in three cuttings. Early maturing varieties of cowpeas will succeed, and early varieties of soy beans may also be used to advantage. All of these crops will do best at the lower mean elevations of the region. They are warm weather crops, and hence will succeed somewhat better in the southern counties than farther north.

The waste of manure on most of the farms is a very serious matter. Only a small part of the urine is saved, and much of the solid excrement is so exposed to leaching processes that its value is greatly lessened.

In general, manure should be put on the land at the earliest possible moment after it is made. Stable floors should be water-tight, and litter should be used. It is of the utmost importance that land plaster be spread over the manure and mixed with it to assist in saving the nitrates. Ground phosphate rock does the same thing and also reenforces the manure with phosphates. Even road dust is highly beneficial in absorbing and holding the liquid, but there is, of course, no chemical change in the soluble nitrates, and no fertilizing constituents are added.

Preparation tillage and later cultivation of crops varies widely in efficiency. The sandy loams in any of the series give little difficulty in being prepared for crops, but much moisture is lost in most seasons by the failure to maintain a dust mulch by the means of frequent shallow cultivations. Consequently the crop does not get the chance to make use of all the season's rainfall, which might just as well have been saved by proper cultivation. The old cut-and-dried method of working crops two or three times and "letting it go at that" may give satisfactory results in a year when the rainfall is ample and evenly distributed, but the distribution of rainfall is not a "cut and dried" matter. Experience has proved that it is variable at crucial

times in the period of crop growth, and the amount of cultivation must conform to weather conditions beyond the mere incidental fact of killing the weeds. It may be necessary to cultivate corn or potatoes from five to seven times instead of the proverbial two or three times. Most of the injury from the extended drought of 1909 could have been avoided if the land in preceding years had been worked under a system of deep preparation tillage and shallow cultivation tillage, and then followed by the latter during 1909 at least as often as once a week until the crops became too big for such working.

The heavy silty loams, the silt loams, and the silty clay loams of the Westmoreland and Dekalb series require more care in working than the sandy types. The proportions of silt, clay, and sand are often such in these soils that they clod badly if plowed or otherwise worked when moisture conditions are not just right. Each farmer should study, largely by observation, the right stage of moisture for working his soil so that clods will not form, and if perchance formed, the stage when they will readily pulverize should be learned.

The Brooke soils are the most difficult, however, to keep in good tilth. The prevailing silty clay loam dries out slowly in the spring, and in the hurry to get crops planted much care has to be exercised, else the soil clods badly and the lumps become very intractable. Fields were seen where the clods were not subdued during the entire season of 1909. Such a condition causes rapid loss of moisture, lessens crop yields, and should be carefully guarded against.

One of the worst features connected with agriculture in the whole region is the lack of enthusiasm for it as a business. The extraordinary wealth attained by the leaders in the development of coal and allied industries, oil and timber, and the lesser though marked financial prosperity of the very considerable group of necessary superintendents, inspectors, mechanicians, foremen, etc., has made many a farmer dissatisfied. This is unfortunate for the individual, for the community, and for farming. This tendency, connected with the hope that the farm coal or oil right might be disposed of to good advantage has done much to kill enthusiasm for farming, yet if farming is to be profitable enthusiasm for it is as essential as to the success of any other business.

Business methods applied to the management of the soil, to its cropping, its fertilization, its cultivation, and then to the marketing of the products would be relatively as effective as are such methods in the numerous industrial concerns of the region.

Few farmers have plans so arranged that they and possibly their sons are working with profit during the winter. In some cases this is not an easy matter to arrange, but there are few cases where the conditions may not be improved. The proof of this is always attested by a few in every community who succeed in doing it.

Opportunities for teaming with the farm horses are usually taken advantage of. This is as it should be, for the expense of maintaining farm teams idle during the winter is a serious economic loss on many farms. But if there is no opportunity for teaming there is opportunity to milk cows which have shown by test of butter fat that it will pay to do it. There is good opportunity in some sections for farmers to establish cooperative creameries.

On a small scale poultry can be kept to advantage if given grass yards or range in summer, and fed in winter on home-grown grain.

Grade Percheron colts are one of the best paying farm products at the present time. Farmers should aim to breed to pure-bred stallions only the best type of farm draft mares that it is practicable to have. Service fees for such sires are now within the farmer's reach. It costs no more to feed a well-bred colt than a mongrel. A good profit with the former is almost certain, but with the latter almost never.

Good mares should be used for farm work, especially if there is only light work for them during the winter, and then if used for breeding purposes they can be made to pay good prices for all feed consumed during the winter. Such colts constitute an excellent home market for farm crops, keep the manure on the farm, and, except for training, the labor is no more than for steers.

Another advantage may be had on many farms in the better division of labor. One man can milk only about ten cows to advantage, but he can also take care of a few colts in addition that will pay as good returns for farm feeds as the cows. He can also care for a few hogs that will be profitable if they have been skillfully produced for the most part on cheap home-grown feeds. In most cases this necessitates a pasture rotation.

The cost of labor and the difficulty of securing it are often given as the chief reason for selling so much hay instead of feeding it on the farm. This is particularly applicable to farms beyond the trucking distance from town. Steers are the principal money product on many farms, because the labor problem is easily solved, even though there may be no profit on the steers.

In some cases extensive farmers feed large numbers of steers, but it is believed that there have been few cases where such course yielded much profit beyond a fair price for the feed consumed. More money has been made in the steer business by fattening a few in conjunction with other kinds of stock and other farm activities than when they are made practically the sole farm product.

Pure-bred dairy cows of any of the dairy breeds are another good product for farmers who could and would like to produce them. The expense of getting started keeps many from taking some part in this business, but it is possible to obtain good producing pure-breds at

reasonable prices. The buyer must understand, however, that there are some scrubs among pure-bred cattle, and he should be guided accordingly.

Sheep were formerly a very important product in this whole region, but they are steadily decreasing in numbers. In many parts of the area the natural conditions for sheep husbandry are excellent. There are still many flocks of 20 to 50 sheep, but the ravages of dogs are resulting in a steady decrease in numbers. In any farming community there are liable to be some worthless dogs to prey upon the pasture flocks, but in every coal settlement there are great numbers of nondescript worthless curs, many of which are only half fed, that play havoc with the sheep business. The appearance of the tax collector is the sign for an annual killing, but even this is not sufficient to make the sheep business safe anywhere near the coal towns. As a result the industry is confined principally to districts at a distance from towns or mining operations.

Hogs will be most profitable probably as an adjunct to other lines of farming, especially dairying and steer feeding. Unless hogs are to utilize farm wastes, by-products, and cheap feeds they can not compete with the product of other regions that can grow corn cheaper than can southwestern Pennsylvania. This is not that grain can not be grown here to advantage, but that it should be used in producing products for which the local markets will pay the highest relative prices, such as eggs, high quality milk, etc.

Poultry products are already of much importance, but there is good opportunity to increase the business.

Cropping systems have not been made to conform to soil conditions in very marked degree. In fact, a heavy economic loss has been steadily sustained in the region by the failure to make such adjustment. Crop systems and rotations should be planned according to the character of the soil on the individual farm and to meet market conditions, but not to any hard and fast system because it has been in use for a century or more, or even because it may still be especially desirable on the soils of a neighbor's farm.

Corn, oats, wheat, and grass, in as many years, has been the standard rotation since early days, and it is still retained by many who would do better to change it. On the Brooke soils, and on the heavy members of the Westmoreland, Dekalb, and Volusia soils, this is an excellent rotation in many cases. There is much complaint, however, that oats are no longer profitable, and in some cases this crop has been eliminated from the rotation. Much damage is done by rust or blight. When oats are not grown, " cornstalk " wheat follows corn. In a few cases wheat is eliminated and grass is seeded with the oats. Oats are a good crop only when they pay, and the mere fact that this crop has a historic place in the good old rotation

is not sufficient reason for growing it. There should be a specific advantage obtained from every crop grown. This advantage may be one of direct profit, or it may be in part or entirely in soil improvement. But in a profitable cropping system convenience may not be the only advantage. Extra labor is involved by growing "cornstalk" wheat, but if land thereby yields a profit greater than can be obtained from the oat crop, then the extra expense for labor is justified.

At this point must be emphasized the necessity for keeping strict account of the cost of producing each crop on a given field. If the results from a given crop do not warrant the expense of growing it some change must be made. The crop must be dropped or methods of cropping must be devised whereby it can be made to pay. There is no alternative. The range of crops is sufficiently broad so that under present conditions some crop may be selected from which with efficient management the returns will at least equal the cost of production.

In the old rotation corn was the only cultivated crop. It was profitable, it is now, and will continue to be under good soil management. It should be the basic crop in most rotations. Potatoes are an excellent money crop for much of the region. They analyze high in water, hence remove little fertility from the farm as compared with a crop of corn or cereals, and the crop fits nicely into several different rotation plans. Soils well adapted to their growth are abundant.

On the silty loam and silt loam soils, then, where stock is kept, and especially on dairy farms, an excellent rotation is corn, followed by peas and oats cut for hay, then clover one year, to be followed by potatoes. The potato crop can be followed with timothy and clover if desired. This plan introduces two legumes in a four-year rotation, thus furnishing a large amount of home-grown protein to help balance the corn in feeding rations. A money crop is also secured in potatoes, which can be grown with a minimum of hand labor if modern machinery is used. A good crop of hay can be secured from the Canada field peas and oats. If the former do not grow well in the southern part of the State an early maturing variety of cowpeas may be substituted. When weather conditions are favorable a seeding of timothy and clover may be made soon after the peas and oats are cut for hay, or the clover may be sown the following spring.

Potatoes, wheat, and clover form another good rotation, especially where little stock is kept, or for part of a farm in conjunction with the longer rotation on the remainder.

Timothy hay is an important money crop throughout the area. It is a shallow-rooted nonnitrogen gathering plant that is very exhausting on soil productivity, consequently it requires careful manage-

ment. A good crop of clover is secured only one year after seeding. Hence if timothy is to be sold as a money crop in either of the above rotations it should be sold the second year after seeding, and for that year only, unless the sod is to be top-dressed—a rare occurrence in this region, at least unless the land has been in sod for several years.

These rotations are not applicable, of course, where coke smoke is sufficiently serious to make reseeding difficult. Under such conditions it is probable that a top-dressing of stable manure will hold the grass to a profitable yield as long as any means, but it too soon becomes ineffective if there is much smoke.

Such rotation, energetically followed, would make farming profitable and increase wonderfully the productivity of the soils. The excellence of some of the soils for potato growing means that they can compete with any district in the whole country in growing this crop for the Pittsburg and surrounding markets. Lime should not be applied to land for some time before a crop of potatoes is to be grown, as it tends to promote scabbiness. In the rotation, including corn, it should be applied for that crop. In the rotation potatoes, wheat, and clover small amounts should be applied immediately after the potatoes are harvested—just as much as experience has shown is necessary to secure a stand of clover—unless potatoes are not to follow the clover in repetition of the same rotation. Under present conditions land is left in sod from three to five years or more by all except the best farmers. As a result the soils do not yield nearly as much as they should.

Buckwheat may be classed as a crop extensively grown, but with no regularity of cropping procedure. An occasional farmer gives it a place in a regular rotation, but usually it is used as a catch crop. When any other crop fails buckwheat is sown, and some return is had from the land that season. In high Dekalb districts in the northern part of the area, where corn is somewhat liable to damage from frosts, buckwheat is often grown as a regular crop. Yields are so extremely variable that no estimates were given under soil descriptions. Twenty bushels is a good yield when the crop is given a fair show, but the general range is from 5 to 30 bushels. Too often buckwheat is used as a money crop, except where other grain of higher protein content is purchased in its stead because of favorable market conditions.

Where most of the hay and other crops are sold for cash a usual method of soil treatment is to apply 200 pounds of commercial fertilizer per acre for oats and wheat. Often a similar amount is applied to corn, though an effort is made to have a little stable manure for this crop. The abuse of this system has had serious effect on the productivity of the farm lands of the region, and it should be so changed as to meet some of the requirements already outlined for

increasing the productivity of the soil, remembering that if land needs lime then lime is the first requisite for successful crop production; that all soils must be well filled with humus, or decayed vegetable matter, and that after these two conditions have been supplied it may be profitable to apply phosphorus and potash, but such application can never pay unless the soil has been put into condition to make the best use of them. And this means that the soil must be slightly alkaline and well supplied with humus. The latter can be supplied by the application of stable manure, by plowing down green crops, or by growing legumes, feeding the forage to stock and plowing down the sod after one year's growth.

The sandy types of soil are variable and the management of crops according to the soil adaptations can not be treated in detail. Sod does not yield profitably as long as with the heavier soils, hence short crop rotations are essential. On the fine sandy loams corn, clover, and potatoes may be grown with success. Some of the more sandy types are not adapted to general farming under present conditions. Garden produce can be grown to advantage on many of the sandy types of soil where market conditions are suitable.

As already indicated in the description of soil series, mistakes have been made in western Pennsylvania in clearing land which is too steep for profitable farming. This applies sometimes to entire farms, but much more often to individual fields included in a farm containing other fields well suited to tillage.

Keen judgment in the selection of farm areas adapted to their several uses is the keynote to farming for profit in many sections of the region covered by this survey. That is to say, these farms often include land so steep that the farm should be managed first from a topographic viewpoint, and then by adaptation of soils to crops. Such farms should be divided into (1) tillable land, (2) pasture lands, and (3) forest lands. Then the plans of management adapted for each of these three conditions should not be permitted to encroach one upon the other. If more tillable land is wanted, some suitable for such purpose should be bought, instead of bringing land suited only to pasture or forestry into tillage. If necessary some woodland or pasture can be sold to obtain funds for this purpose, but these three plans of management should be kept distinct, and balanced in the farm economy.

The exceptionally good markets of western Pennsylvania make very profitable the growing of all sorts of vegetables on soils in the region adapted to their growth. In many cases a better profit is obtained retailing or even by wholesaling in the numerous towns than in shipping to Pittsburg. For early and medium grade crops the fine sand and the fine sandy loam of both the Westmoreland and Dekalb series are well adapted, while the silty loams of the same series are

suitable for later successions of the same crops, or for later maturing garden crops.

The horticulturist or farmer may specialize to suit his fancy. The number of wealthy families is sufficient to create one of the finest markets in the world for the very best of food products. The multitude of mine workers and other industrial laborers require enormous quantities of staple food products for which they pay good prices, and others consume in the aggregate large quantities of some of the coarser and cheaper materials. This does not mean that there is demand for inferior foods in the vegetable line, but that wholesome vegetables and cheap cuts of meat are consumed in large quantities by the workingman. His hard manual labor requires a good diet consisting largely of the coarser yet nourishing foods, and whenever there is work he has the money to pay for such foods, and is ready to do it.

ORCHARDING.

Orcharding receives little attention except in special instances. Within reach of coke smoke the trees are not only injured, but even where the amount of soot deposit is small it makes the fruit almost unsalable.

Away from this influence selected areas are well adapted to the production of apples, pears, and plums. Peaches succeed very well in some localities, but as a whole the region is not very well adapted to them. Apples, pears, and plums do very well in the present farm orchards considering their prevalent neglect. Spraying is rarely attempted, although various orchard insect and fungus pests were plentiful during the season 1909. The few who are making fruit one of their money crops usually spray with fair efficiency. Such men often cultivate, fertilize, prune, and otherwise care for their orchards. Only by such methods can orcharding be made to pay.

Few young orchards are being set out, and there is little enthusiasm about planting. Neither is there organized effort to control orchard pests, or to further orchard interests in other ways.

Orchards should not be set in localities where coal is later to be mined. These exact locations can not be foretold, but in many cases the veins have been carefully plotted on the folio maps of the United States Geological Survey, and a study of such location or vein exposure will indicate in a general way places to be avoided.

It must be realized that all the high hilltops are exposed to the full sweep of strong winds, a characteristic of unsheltered locations on the west side of the Allegheny Front.

Notwithstanding these various difficulties, there are good opportunities for fruit growing and orchard planting if suitable locations and soils are selected with these points to be avoided in view. Such development should be shaped in most cases according to local mar-

ket requirements. At present the excellent home markets of the area are fully supplied with local fruits in few instances, and still more rare is it that the best quality of fruits in demand are home grown, with the exception in a few cases of small fruits.

The Baldwin and Northern Spy are the two leading commercial varieties of apples for the region as a whole, and the Spy is better in the northern part than near the Maryland line. The Baldwin has been the most dependable variety. The Ben Davis bears no more fruit than the Baldwin, so there is little reason for planting it for local markets, where its superior shipping character is of little advantage.

The Rome Beauty is a fairly good sort for the lower elevations south of Beaver Falls and west of Chestnut Ridge, but farther north it has not succeeded nearly as well as the Baldwin. The Rome has done best here on the heavy, fine sandy loams, and mellow, light silty loams of the Westmoreland series, and on similar types of the Dekalb series. Of both these series the mellow, silty loams with silty clay loam subsoils are adapted to the Baldwin.

The Rhode Island Greening is not grown to advantage in this area, as it tends to drop early in the fall and in any case does not keep late enough for the standard of this variety.

King grows very well, but is not sufficiently prolific for profit. Smokehouse is a popular variety in the southern part of the area, but few are grown in the northern part. Fall and Winter Rambo are both found and give general satisfaction in local markets. Pennock has done well as a commercial sort in some instances, but has not been widely planted. York Imperial, a standard in eastern Pennsylvania, is little seen here, and has not given very good results where planted.

In the southern counties where there is less cold weather than farther north Grimes and Fallawater are both grown with some success. Ben Davis yields well, but is not extensively planted.

SUMMARY.

(1) Eleven counties of southern Pennsylvania, embracing an area of 7,911 square miles, were surveyed.

(2) The area surveyed is a part of the Allegheny Plateau, which is a broad, rolling upland that has been deeply dissected in many places.

(3) There are four series of upland soils: The Dekalb series, derived from sandstones and shales; the Westmoreland series, separated from the Dekalb because of lime content, is derived from shales, limy shales, and thin-bedded limestone; the Brooke series, derived principally from limestones with slight commingling of shales, and the Volusia series, derived from glacial débris; one series

of colluvial soils, the Jefferson series; and four series of terrace and bottom-land soils, the Wheeling, Kittanning, Huntington, and Genesee series.

(4) The rolling soils are capable of supporting a thrifty agriculture, and steep areas are suitable for permanent pasture or forest.

(5) Agriculture formerly prospered. The discovery and exploitation of rich beds of soft coal led to a high degree of industrial development, especially in the southwestern part of the area, and farming became relatively less important.

(6) The removal of coal veins has caused land to cave in to some extent. This is much less serious to cropping than the removal of the ground water by mine shafts. Smoke from the coke furnaces destroys nearby vegetation and injures it for considerable distances.

(7) Because of the exceptionally good local markets for farm products afforded by population allied with the extensive industries, soil areas free from difficulties outlined in (6) offer excellent opportunities for further agricultural and horticultural development.

(8) Important areas of soils occur well adapted to the production of special food products for these local markets. This includes all sorts of horticultural and animal products. At present large quantities are brought from outside the area. This is the best line for development.

(9) Dairying and general farming can be followed to advantage on the Brooke series and the heavy members of the Westmoreland and the Dekalb series.

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U.S. DEPT. OF AGRICULTURE
BUREAU OF SOILS
MILTON WHITNEY, CHIEF

SOIL MAP

RECONNOISSANCE SURVEY, SOUTH WESTERN PENNSYLVANIA SHEET

PENNSYLVANIA STATE COLLEGE
AGRICULTURAL EXPERIMENT STATION
THOMAS F HUNT DIRECTOR

LEGEND

RESIDUAL SOILS

Dekalb soils — D

Westmoreland soils — W

Brooke soils — B

Upshur soils — U

GLACIAL SOILS

Volusia soils — V

COLLUVIAL SOILS

Jefferson soils — J

TERRACE AND BOTTOM-LAND SOILS

Wheeling soils — Wh

Kittanning soils — K

Huntington soils — H

Genesee soils — G

Steep broken topography

Figures throughout map indicate elevations

Rough mountainous topography

BOUNDARY LINE

Soils Surveyed by
Henry J. Wilder of the U.S. Dept. of Agriculture
and Charles F Shaw of the
Pennsylvania Agricultural Experiment Station
1909

Scale 1 inch = 4 miles

ECKERT LITHO. CO. WASH. D.C.

Field Operations
Bureau of Soils
1909